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- 4 x 1G/100M/10M Ethernet LAN ports with 1 million NAT sessions
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- Object-oriented SPI Firewall
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- Supports VigorACS 2 & VigorACS 3 Central Management Software for remote management
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- Supports Central Switch Management (up to 30 Vigor Switches)
- Rack-mountable
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Vigor2962P

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- 2 x GbE configurable LAN/WAN ports *
- 1 x 2.5GbE configurable LAN/WAN port *
- 1 x 1GbE combo SFP Fibre / Ethernet configurable WAN/LAN port
- Multi-WAN Load Balancing & Failover
- Up to 5 x Gigabit LAN ports with 300,000 NAT sessions
- 2.2 Gbps NAT throughput
- 4 x Gigabit PoE LAN ports with a total power budget of 65 Watts (Vigor2962P)
- Object-based SPI Firewall, Content Security Management (CSM) and QoS
- 200 x VPN tunnels (including 50 x OpenVPN/ SSL-VPN tunnels) with comprehensive secure protocols
- Up to 1 Gbps site-to-site IPsec VPN throughput
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- 20 x VLANs and LAN subnets for secure and efficient workgroup management
- IPv6 & IPv4
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- Bandwidth management
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EDITORIAL

WHAT'S INSIDE *APC*

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EDITORIAL

Online privacy

Let's have some more of that...

BEN MANSILL
Finds Facebook genuinely useful a couple of times a year.

Hi everyone, I hope you made the most of the non-stop and seemingly endless winter, and are now out and about a bit more getting your Vitamin D from the sun, not a pill.

It can feel a bit oppressive and never-ending, too, when you're on your PC or device and every day just brings more emails you don't care about, notifications for apps and accounts you haven't used in years, and the never-ending screams for attention from all the social networks you're hooked into that demand constant attention.

It's draining, time wasting and all so unnecessary. So, in this issue of *APC* we're going hard on quieting the noise, and helping you get some sanity back. Our guides will show you how to disconnect from the pollution of the net, and leave only the things you actually want to spend time on. So dive in and declutter your life. Our guides cover many areas, so you can tailor your online life to be exactly how you like it. It's time well spent, I promise, and the longer you leave it the worse it's going to get...

Our second big project this month is a bit of Windows 11 tweaking. Widgets are back, and we love them, but given how in your face they are on the desktop, a bit of tidying and organising is in order, and we'll show you how to make your own custom widgets to make your PC more like the home base it should be. It's quite enjoyable to go through these tweaks, and if you're looking for a nice way to have a bit of a PC fidget, this is a very pleasant time consumer.

Looking ahead, the *APC* team has put together an excellent overview of the future of storage. I know that doesn't sound particularly exciting, but as we've just entered the PCIe 5 era with Ryzen 7000 and AM5 platform support, it's time to look and see what's going inside your next potential build or upgrade. We examine the tech that makes it tick, and the gear to look for so you're well prepared as you balance your upgrade priorities.

In house news, our talented Creative Director Troy has been working on readability tweaks in your *APC*, making things a bit better for those without jet fighter pilot eyeballs.

Have a great month everyone, get out there, and we'll see you in the next *APC*.

CORRECTION In *APC* 511 our feature story The Future of the PC unfortunately contained some text that repeated itself, and as a result portions of text were also missing. We sincerely apologise for this error and the inconvenience it may have caused.

The feature has been corrected and is available to view or download as a PDF at tinyurl.com/APC511futurepc

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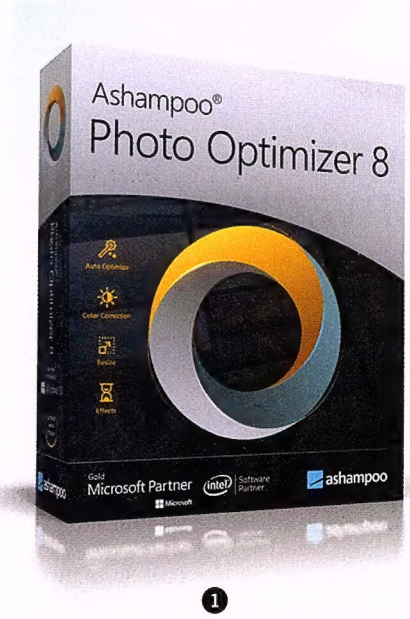

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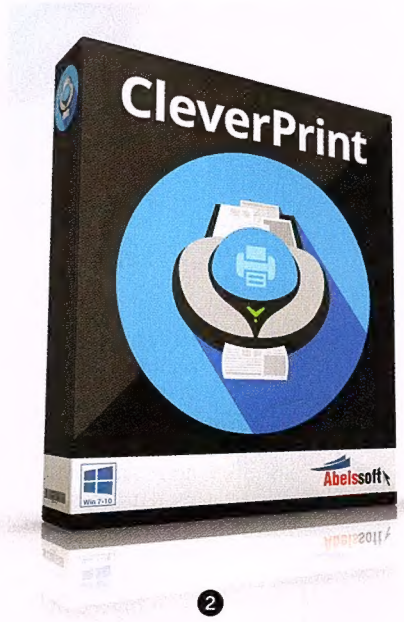

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ABELSSOFT CLEVERPRINT

Ecological printing with CleverPrint

Conserving resources, conserving money – these things are especially important in the workplace. CleverPrint for Windows succeeds in saving huge amounts of paper in the course of daily printing. The ink-saver function saves unnecessary toner and ink consumption. Office printing can quickly take a bite out of one's wallet – but CleverPrint for Windows has the muzzle to put a stop to it. The software targets wasted paper in the workplace and home office. Up to 50 percent of paper resources can be conserved with little, clever tricks. One such technique is to display a preview of the print job in order to prevent unnecessary mistakes. One can even remove entire pages at if they discover they're superfluous or blank.

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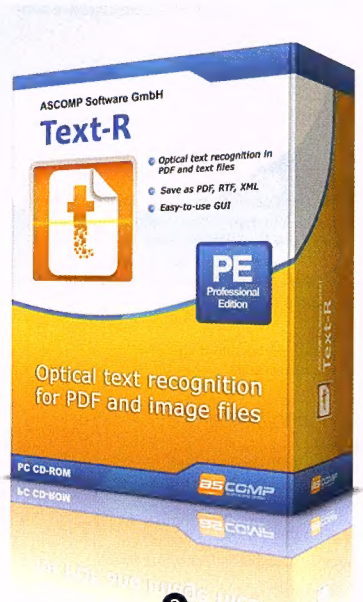

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ASCOMP TEXT-R 2.0

Simple optical text recognition (OCR) for Windows.

The problem: PDF files and images from a scanned paper document contain text that cannot be copied or edited. However, manual typing is not possible due to the size of the document and the high time involved.
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The built-in dictionaries and professional OCR filters ensure high accuracy in text recognition. In this way, skewed texts and rotated documents can also be detected.

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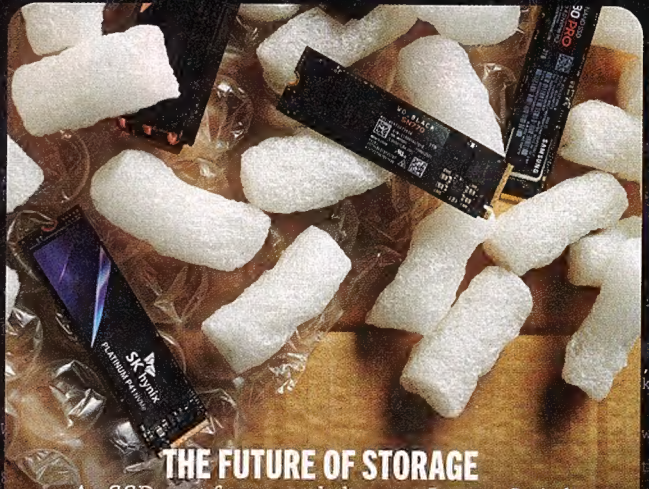

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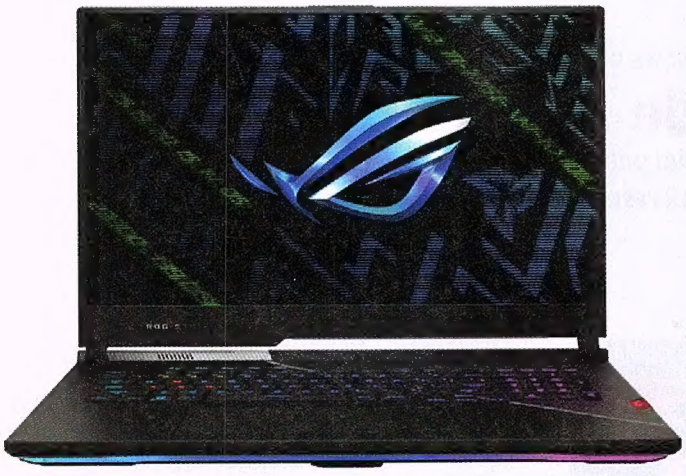

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HOW WE DO IT

Inside *APC*

Find out all about APC's editorial policies, test practices, how to read the benchmark results, and more.

"Championing technology doesn't mean we're unrelenting yes-men and -women, however, and *APC* aims to be as objective as possible in all our coverage."

APC is Australia's oldest consumer technology magazine – having been consistently in print for forty years, since our first issue way back in May 1980 – and we take that heritage and responsibility very seriously. While our focus is obviously on the personal computer the very definition of the PC has changed and shifted markedly since the early 1980s. As such, we touch on many other areas of tech, too, from smartphones and apps to peripherals, accessories, and beyond. We have two goals: to find the best modern tech and to help you make the most of it.

We're also an open church in terms of platforms. We know most people aren't wed to a single brand's products and use a variety of devices. And, like you, *APC*'s journalists want to know what's good in tech – no matter what platform it resides on.

Independent reviews

Championing technology doesn't mean we're unrelenting yes-men and -women, however, and *APC* aims to be as objective as possible in all our coverage. That means identifying the best products from multiple perspectives – the best performance, best value and best features and, ideally, the products that offer the best mix of these three attributes.

As a matter of policy, reviews published in *APC* are not shared with product-makers prior to print. We will contact vendors under certain conditions; for example, if we have a problem testing a product that seems to indicate it may be faulty, or to invite a vendor to clarify how a particular feature works. If an *APC* reviewer has any potential conflicts of interest involving a brand, the review will always be assigned to another writer.

Labs testing

APC strives to conduct the most rigorous, objective scientific tests and benchmarks we can so as to make our reviews as unbiased as possible. We use a variety of tools and programs for this, including many freely available benchmark suites for assessing media encoding, general system performance including storage read and write speeds, gaming and battery life.

In most cases, for the benchmark results published in *APC*, you can assume that higher is better. There are certain tests that deviate from this rule where the opposite is true; in those cases, we've flagged the results with a note explaining as such.

We use both tables and graphs for displaying results; the latter offers better ease-of-readability, but tables are more compact, so we use these in most cases where thoroughness is preferred.

apc TESTBED

The current APC testbed used in the Labs for benchmarking all components. This testbed is updated as new and relevant technology comes on stream.

CPU	AMD Ryzen 7 5800X
Motherboard	Asus ROG Crosshair VIII Dark Hero
GPU	Zotac RTX 3080 Ti AMP Extreme Holo
Memory	Crucial Ballistix Sport DDR4-3600 2x16GB
Primary SSD	Adata S70 2TB NVMe
Secondary SSD	Samsung 980 Pro 500GB NVMe
Cooling	Nzxt X73 360mm AIO
Case	Thermaltake Core P8
Power Supply	Corsair AX1000

apc AWARDS

APC EDITOR'S CHOICE

When a reviewed product scores 4.5 out of 5 or higher, it carries the Hot Award. These are products that exceed expectations and deliver a quality experience up there with the very best.

APC HIGHLY RECOMMENDED

You will see this award if a reviewed product has scored four out of five stars. It means most people can expect satisfying performance from the product, and that we would use it ourselves.

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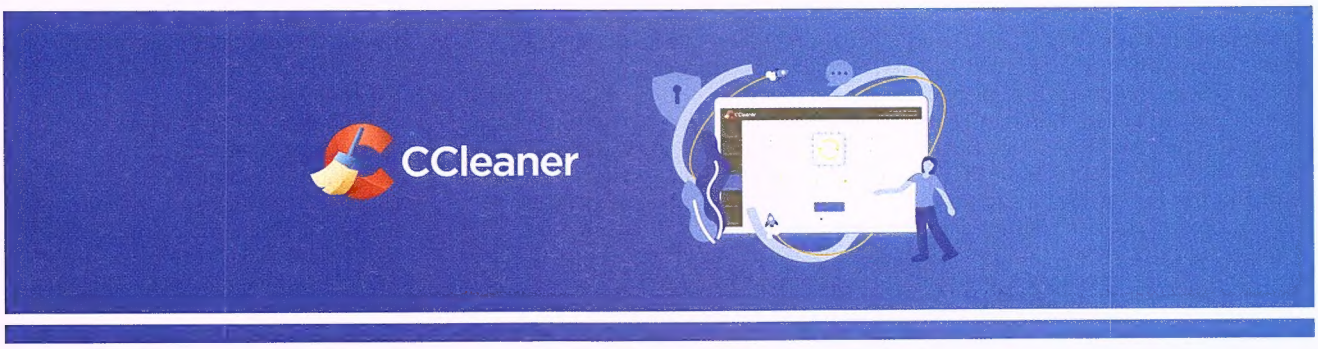

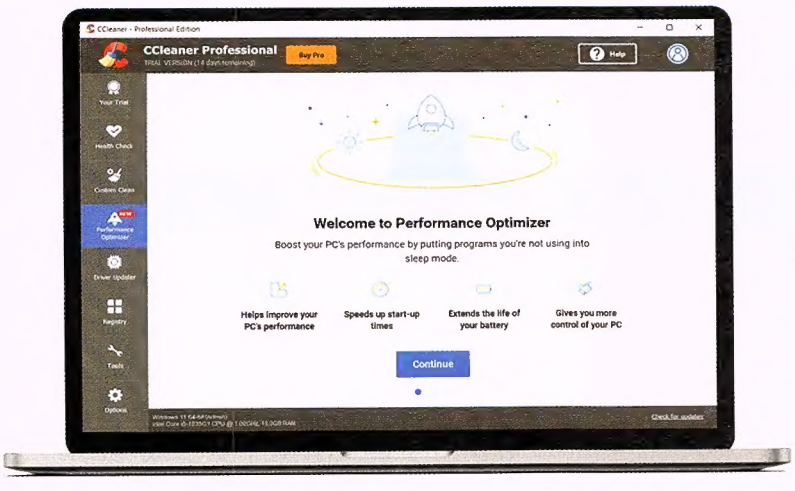
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CPU

AMD launches Zen 4 Ryzen 7000 CPUs

Into the 5nm era we go, with higher clock speeds and a hefty performance gain.

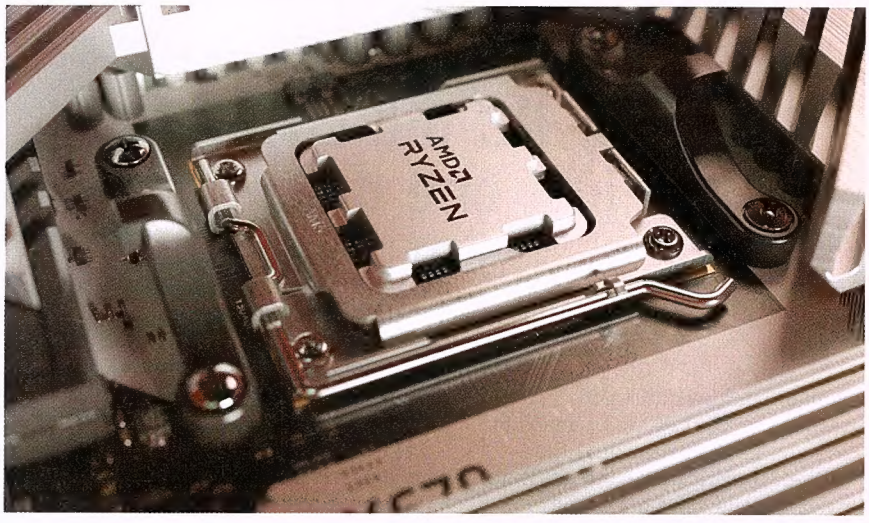
AMD has unveiled its 5nm Ryzen 7000 lineup, outlining the details of four new models that span from the 16-core USD$699 Ryzen 9 7950X flagship, which AMD claims is the fastest CPU in the world, to the six-core USD$299 Ryzen 5 7600X, the lowest bar of entry to the first family of Zen 4 processors.

Ryzen 7000 marks the first 5nm x86 chips for desktop PCs, but AMD's newest CPUs don't come with higher core counts than the previous-gen models. However, frequencies stretch up to 5.7 GHz – an impressive 800 MHz improvement over the prior generation – paired with an up to 13 percent improvement in IPC from the new Zen 4 microarchitecture. That results in a 29 percent improvement in single-threaded performance over the prior-gen chips. That higher performance also extends out to threaded workloads, with AMD claiming up to 45 percent more performance in more demanding applications.

AMD says these new chips power huge generational gains over the prior-gen Ryzen 5000 models, with 29 percent faster gaming and 44 percent more performance in productivity apps. Going head-to-head with Intel's chips, AMD claims the high-end 7950X is 11 percent faster overall in gaming than Intel's fastest chip, the 12900K, and that even the low-end Ryzen 5 7600X beats the 12900K by five percent in gaming.

AMD accomplished the improved performance through several advances, but widening the front end to better feed the execution units and improving branch prediction account for 60 percent of the IPC gain. AMD also increased the op-cache by 1.5x, improved the load/store units, and doubled the L2 cache capacity.

AMD also claims to deliver better power efficiency in a much smaller package than Intel's Alder Lake processors. The company compared its Zen 4 core to Intel's Golden Cove to highlight that it is half the size at 3.84mm2, yet wrings out 47 percent more power efficiency.



The Ryzen 7000 processors will be joined by new DDR5 memory products that support new EXPO (EXtended Profiles for Overclocking) profiles. AMD's partners will also offer a robust lineup of motherboards – the chips will snap into new Socket AM5 motherboards that AMD says it will support until 2025+. These motherboards support DDR5 memory and the PCIe 5.0 interface, bringing the Ryzen family up to the latest connectivity standards.

The X670 Extreme and standard X670 chipsets arrive first in September, while the more value-oriented B650 options will come to market in October. That includes the newly announced B650E chipset that brings full PCIe 5.0 connectivity to budget motherboards, while the B650 chipset slots in as a lower-tier option.

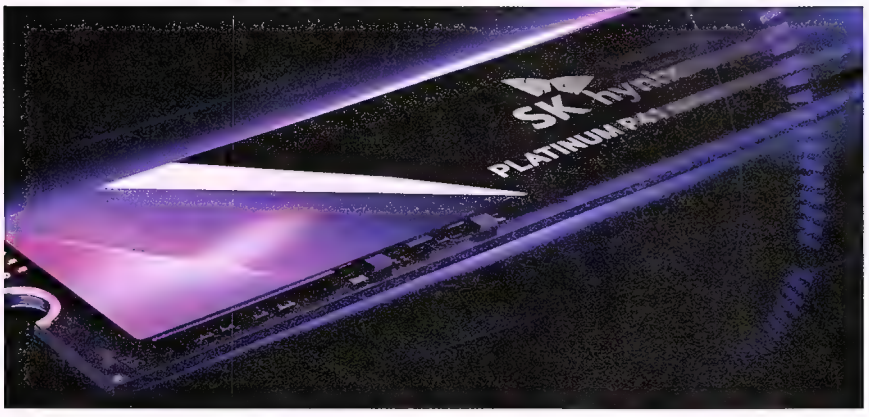
The Ryzen 7000 lineup also brings integrated RDNA 2 graphics to all of the processors in the stack, a first for the Ryzen family. These new iGPUs are designed to provide a basic display output, so they aren't suitable for gaming. However, this feature does improve Ryzen's positioning in several market segments.

MD's Ryzen 7000 platform requires DDR5 memory that continues to command a premium over DDR4, and that will add to the overall system cost. In contrast, Intel's looming 13th-Gen Raptor Lake processors have the option for either DDR4 or DDR5 memory, providing a more value-centric option.

APC is currently testing Ryzen 7000 samples and AM5 boards, and in the next issue we'll have all our conclusions and an analysis of the new platform, as well as a collection of new AM5 motherboards Labs tested.

AMD RYZEN 7000 ZEN 4 SPECIFICATIONS

	Price	Cores / Threads	Base / Boost Clock (GHz)	Cache (L2+L3)	TDP / Max	Memory
Ryzen 9 7950X	AU$1,149	16 / 32	4.5 / 5.7	80MB (16+64)	170W / 230W	DDR5-5200
Ryzen 9 5950X	US$546	16 / 32	3.4 / 4.9	74MB (8+64)	105W	DDR4-3200
Ryzen 9 7900X	AU$899	12 / 24	4.7 / 5.6	76MB (12+64)	170W / 230W	DDR5-5200
Ryzen 9 5900X	US$398	12 / 24	3.7 / 4.8	70MB (6+64)	105W	DDR4-3200
Ryzen 7 7700X	AU$659	8 / 16	4.5 / 5.4	40MB (8+32)	105W / ?	DDR5-5200
Ryzen 7 5700X	US$268	8 / 16	4.6	36 (4+32)	105W	DDR4-3200
Ryzen 5 7600X	AU$499	6 / 12	4.7 / 5.3	38MB (6+32)	105W / ?	DDR5-5200
Ryzen 7 5600X	US$199	6 / 12	3.7 / 4.6	35MB (3+32)	65W	DDR4-3200



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SSD

SSD pricing could tumble

NAND prices predicted to drop by 35 percent.

The semiconductor industry analysts at TrendForce have highlighted a likely seismic shock on the way to the NAND Flash market – the firm's investigations indicate that manufacturer inventories are reaching a "breaking point" because the usual "peak season" demand surge failed to materialise this year, with a fall of around 30-35 percent predicted. These estimates are all the more jarring as they are expected to occur in a single quarter, the current Q3 2022. Moreover, with NAND flash ICs being a key cost component of SSDs, we should expect price cuts to seep through to consumer SATA and NVMe SSD models.

Moving into Q4 2022, TrendForce expects manufacturers to strive to maintain market share at all costs, exacerbating oversupply and the need to make irresistible deals with NAND Flash consumers. It doesn't say when it sees this rapid downward trend bottoming out, but that flash pricing will likely continue the downward pricing trend into next year.

In brief, things look good if you are in the market for a replacement or expansion SSD. Prices should drop for those with patience, and not much patience should be needed to get more for your money.

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USB4 VERSION 2.0 WITH 80GBPS SPEEDS IS COMING

Hopefully without a bonkers name.

The USB Promoter Group(opens in new tab) has pre-announced the next USB version. USB4 version 2.0 promises to deliver speeds of up to 80Gbps. That's double the 40Gbps speed of USB4 and Thunderbolt 4. The technical details are still being worked on, but some of the key characteristics include the aforementioned 80Gbps support, type-c connectors, a higher power delivery spec, backwards compatibility with previous USB and Thunderbolt 3 standards, and support for the latest DisplayPort and PCIe specs.

In a welcome move, existing 40Gbps USB cables should support up to 80Gbps transfer rates, so a good quality 40Gbps USB cable should remain perfectly viable for many years to come. Even more interesting is the claim that the new spec will allow USB 3.2 devices to potentially exceed 20Gbps.

© Evan Blass

LEAKED IMAGES SHOW LOGITECH'S NEW HANDHELD GAMING CONSOLE

The G Gaming handheld looks a little familiar.

A few weeks back Logitech G announced that it was teaming up with Tencent to work on a game streaming handheld. Thanks to leaked images, we now know what the handheld and its UI might look like. The three images that found their way to Evan Blass' Twitter account were quickly DMCA'ed by Logitech G. The speed at which Logitech G responded gives us a feeling these photos are the real deal.

One of the leaked screenshots includes the UI, with icons for some of the apps available from the Google Play Store such as Steam Remote Play, Nvidia GeForce Now, Google Chrome, Youtube, and Xbox. Logitech G has already said that the device will support multiple cloud gaming services.

INTEL HITS OUT AT RTX

Is Intel set to beat Nvidia at its own game?

Intel is confident it has designed its upcoming A770 and A750 graphics cards to match Nvidia's RTX 30-series GPUs, or perhaps even surpass them, in ray tracing performance. Ryan Shrout and Tom Petersen from the Intel Graphics team told us: "The RTU [ray tracing unit] that we have is particularly well suited for delivering real ray tracing performance, and you'll see that when you do ray tracing on comparisons with an [RTX] 3060 versus A750 or A770, we should fare very, very well."

That means Intel believes its ray tracing acceleration is capable of matching Nvidia's 2nd Generation RT Cores, at the very least. Though we would assume Petersen's comments should be taken as a comparison of like-for-like RT performance, meaning the A770 is competitive with the RTX 3060. ■

TECH BRIEF

Has the NFT bubble burst?

Sales slump as market decides "no one wants a gorilla with a hat on."

Are NFTs on the way out?

It was only a few months ago that NFTs were the hottest trend in tech. Celebrities from Paris Hilton to Snoop Dogg were cashing in, and tech visionaries were imagining how the metaverse could be built on the back of non-fungible tokens.

Now it appears that – like tulips and Beanie Babies before them – the hype-train may have hit the buffers.

> "Now it appears that – like tulips and Beanie Babies before them – the hype-train may have hit the buffers."

According to The Block, a site that compiles NFT data, weekly NFT trading volume fell dramatically from a high of $1.63bn last May to a much more sluggish $77.36m in mid-August. Similarly, weekly NFT sales have fallen from almost a million per week at the end of last year, to around 280,000.

The downturn can also be seen in the behaviour of crypto firms. OpenSea, the largest NFT marketplace, has announced that it is laying off 20 percent of its staff in response to what CEO Devin Finzer calls the "crypto winter". In June, Coinbase, the best-known crypto platform, laid off 1,100 staff. Has the NFT bubble burst? Has the market tired of Bored Apes?

"I started last July [2021], and you could have sold a picture of anything," said Mark Shaw, an NFT investor and enthusiast. "The market was crazy. The money was rolling in, everyone was buying, flipping, and selling."

He describes how, at the market's peak, he was buying between three and five NFTs every day, and selling them the next day, doubling his money – or even more. "We all dived in believing it was a never-ending money-making machine," said Shaw. "It was always going to go up. You buy [into] a quality project, if you could find one, [and] it was just going to make you money forever, it was always going to go up."

Shaw first noticed signs of trouble in October last year when, at the height of the market, the transaction fees to 'mint' new NFTs – known as 'gas' fees – went from around $7-15 to as much as $220. This is when he believes things started to turn.

"The fees went up dramatically, ridiculously high and that started to put a bit of a kibosh on [transactions], because who's going to buy an NFT for $20, when the cost of [transactions] is $200?"

With the more recent downturn however, 'gas' prices have fallen again, but Shaw still sees an ominous sign. "Now the gas fees are $5-15 and still no one's buying them," he said.

However, it isn't only the fees. Shaw attributes the downturn to two other major factors: the broader bleak economic picture, which he believes is leading NFT owners to cash out to pay their bills, and the reality of the NFT space being riddled with hackers and scammers.

"Every day I read about people getting hacked, they're clicking on links, losing all their NFTs, losing all their money," said Shaw. "People don't really understand this is not putting your money into the bank. This is completely unregulated. One click of a wrong thing, you lose it all. There is no comeback. There's no one to get it back. There's no help desk, there's no ombudsman, there's nothing. For the last year, you basically had pictures of animals wearing scarves, sunglasses and hats," he said. "I think that's run out of steam. No one wants a gorilla with a hat on."

Francisco Pires ■

TECH BRIEF

Apple using an "old" chip in the iPhone is a good thing

Fast enough is fast enough.

I'm not going to be buying an iPhone 14 for many different reasons, but there is one thing about it I really like – the fact that the "lesser" models are using last year's Bionic chip. This is something I hope we see more of because it's really the best thing that could happen to the smartphone industry.

Apple's iPhone 14 comes in several different flavours. You have the iPhone 14 and iPhone 14 Plus that are positioned as models for most users, and the iPhone 14 Pro and iPhone 14 Pro Max that are marketed towards the smartphone professional, whatever that is.

The cheaper models are using the older but very capable A15 Bionic that debuted in last year's models, while the more expensive Pro models are using a newer A16 Bionic chip that is better because 16 is one more than 15. Both models have the same connectivity options and run the same software. There are other hardware difference like camera configurations, but these don't have anything to do with the chip inside.

I think every company that makes phones could do this – using existing hardware that is fully capable to power new phones while using brand new chips in the Ultra expensive "pro" models for the true hardware chasers.

We see something similar from every other smartphone maker, where cheaper phones use less powerful hardware. Samsung's A-series phones are a great example of this. And of course, there will always be super cheap phones using whatever chip can be sourced for just a few pennies. Those should still be made, too, because not everyone wants or needs to spend more than $500 on a phone.

What's missing though, is a true "flagship" model that is fully featured, has all the rest of the gadgets and gizmo features, but is using last year's Snapdragon chip. And that's where consumers could benefit. Think about the Galaxy S21 FE if you will. The biggest complaint about it is the price tag. Nobody wanted a phone with lesser general hardware specs for the initial price, especially when the better standard Galaxy S21 was out there for less because of sales and discounts.

The smart money move was to buy a Galaxy S20 or another awesome older phone at a big discount instead. The same Snapdragon processor that the company raved about when it released the S20. It had to cut corners and costs somehow. In fact, that processor runs the very same software just as well as the "upgraded" Snapdragon 888 in the S21 FE does and has mostly the same connectivity options.

Of course, the company benefits from this decision because it doesn't have to deal with getting 100 million new chips made to slap them in 100 million new phones. This is big deal now that the world has reached the point where fabrication plants just can't keep up with demand.

I'm more concerned with how we benefit though and having more choices when it comes time to buy a new phone is always better. A Galaxy S23 with the same chip as the Galaxy S22 would be great to use and would save us money.

Enough trying to tie this to actual products filled with "what-ifs" and "I wish-es." Apple users have the opportunity to buy a phone that's fully capable and will be fully capable for the next few years and that's great.

Jerry Hildenbrand ■

There are many advantages to 'good enough' in this new world.

END USER

Earn to play, or play to earn?

The games industry is still fuzzy on blockchain implementation, but there are valid arguments on both sides, writes Shaun Prescott.

Shaun is an Australian editor for *PC Gamer*, *GamesRadar* and *PLAY*, and writes for *APC*, *TechRadar* and more.

If you're among the presumably millions of videogame enthusiasts who don't mind not earning money while playing videogames, then bad news: you may be an idiot. At least, that seems to be the attitude among blockchain-based game developers and enthusiasts. While large publishers haven't made that claim, obviously, a recurring theme throughout the last two years has been companies like Ubisoft, Square Enix, Valve and Microsoft making declarative statements around their intent in the space.

The most common and obvious application of the blockchain in games is to confer real value on digital assets. Whether that means something that already exists and which is traded (for example, a developer-made red cape) or the labour of a user which is traded (for example, an amount of earned in-game currency or harvested goods) there's clearly a tonne of opportunity. Indeed, many of the most popular games seem designed for this kind of economy, ranging from MMOs like *World of Warcraft*, through to popular shooters like *Counter-Strike: Global Offensive* (the latter has an enduring, non-blockchain item economy that fluctuates wildly, with a shady grey market). Basically, all live service games ranging from *Fortnite* through to MultiVersus have very obvious ways they could incorporate the blockchain.

As for existing blockchain games, *Axie Infinity* is probably the most popular. Developed by Philippines studio Sky Mavis, it's basically a smartphone-based *Pokemon* clone that allows users to earn via the usual *Pokemon* clone activities: breeding monsters, setting monsters against one another in battle, and of course, trading those monsters, which are NFTs. According to a CNBC report, people have been able to earn a living playing *Axie Infinity*. (Earlier this year it was hacked, which resulted in $600 million being stolen, and the in-game economy going to wrack and ruin).

> "It's a big PR struggle: gamers – or at least a lot of them – are averse to the industry taking up play-to-earn en masse."

Square Enix, the major Japanese publisher whose popular *Final Fantasy XIV* MMO seems ripe for the blockchain treatment, became a 'node validator' (basically, a crypto authenticator) of the Oasys blockchain last month. Square Enix has threatened this kind of blockchain uptake for at least a year, but has now dived head first in. On the other hand, after nearly as long expressing interest in blockchain-based development, Ubisoft implied in September that its enthusiasm has cooled.

It's a big PR struggle: gamers – or at least a lot of them – are averse to the industry taking up play-to-earn en masse. It's understandable, because monetising recreation does come across as a little cynical at best, and the pinnacle of capitalist exploitation at worst. Sure, it's hard to argue with money earned from pleasure – as virtual as it may be – but in a world awash in blockchain games, those games will adapt to the play-to-earn model: play-to-earn will not adapt to them. That means, in a worse case scenario, the whole medium turns into a grindy morasse of tedious labours, rather than, you know, fun.

On the other side of the coin (and leaving aside the deleterious environmental factors, and the ubiquity of scams) it does make sense for games that already harness virtual economies: developers of popular live service games rely on user engagement for profit, and while the user is ostensibly getting "fun" in exchange, they're usually not seeing any money. Would it be bad if they did? If AJwrecka56 spends 24 hours harvesting virtual wheat to bake virtual bread to sell it to roleplaying adventurers, is that play or labour? ■

© Getty

Is the MacBook Pro 13 redundant?

The iconic MacBook Pro 13 may be destined to go the way of the late MacBook.

After reviewing the new M2 MacBook Air from Apple in the last issue of *APC* (issue 511, page 34) we couldn't help but wonder why Apple even has a MacBook Pro 13 anymore. From a consumer perspective more choice is always better, so we by no means think it's a bad thing that Apple is offering a 2022 M2 MacBook Pro 13, but Apple hasn't been afraid of radical product shifts in the past and if you break it down, there's really no need for the 13-inch MacBook Pro anymore.

When Apple shifted from using Intel processors to its own in-house silicon, it had to make a big change to using an ARM-based reduced instruction set processor (RISC). The type of coding language used by RISC processors simplifies the commands given to the computer by writing a more extensive command language. This reduces the actual processing power required by a chip and allows it to operate faster. While the coding for the instruction language is longer and relies more heavily on RAM, memory isn't expensive these days and Apple's development of Unified Memory, which is built into the SoC, allows it to operate much faster than Intel's Complex Instruction Set Computing (CISC) processors for many tasks.

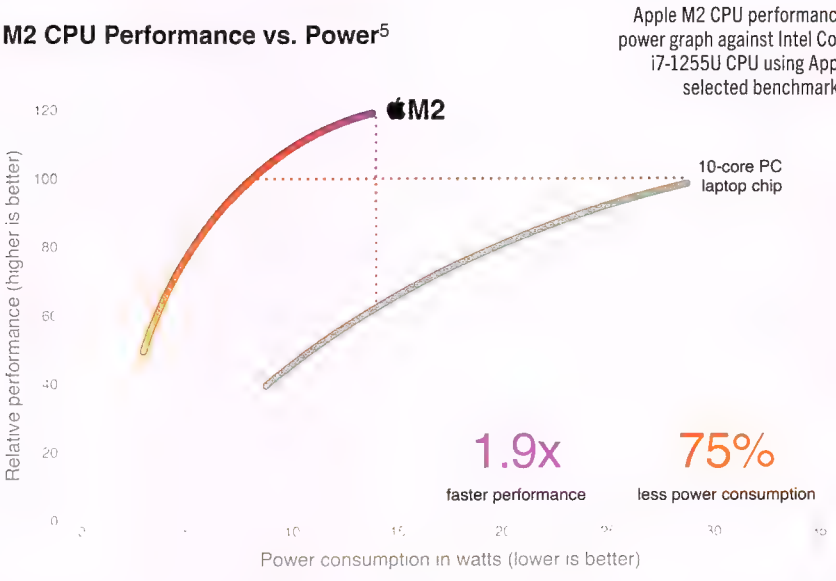
While Apple has done a pretty amazing job squeezing comparable, if not better, performance out of its laptop processors, what is even more consequential is how much power a RISC processor uses to perform the same function. If you've looked at Apple's marketing you will have seen the graphs showing power consumption plotted against performance, and if you follow Apple's benchmark methodology you'll get equivalent processor performance from the M2 and Intel's Core i7-1255U CPU while consuming 75 percent less power. This difference means that Apple is able to get considerably more lifespan out of its laptop batteries, but it does mean that the processors are hotter at lower wattage inputs.

> "Based on the fact that the only major update to the 2022 MacBook Pro 13 was the use of the M2 processor, we think Apple might be thinking that actively cooling its entry processors might be more work than it's worth."

As you get closer to a processor's peak performance you are going to get diminishing performance returns from how much power you put in. At a certain point all the tiny transistors and resistors in any processor heat up to a level that could cause damage, at which point performance will be curbed for self preservation. Laptops with active cooling use air circulation to increase this threshold by keeping the processor cooler under load, but Ultrabooks often sit on the edge of the point where active cooling is used at all.

One of the major historical differences between the MacBook Air and the MacBook Pro 13 was the fact that one was cooled only by the ambient air, while the Pro offered internal fans for a bump in performance. CPU benchmarks for the late 2020 M1 MacBook Air and M1 MacBook Pro 13 were virtually identical and in the 2022 Air and Pro 13 laptops the difference is no more than a few percent for CPU based tasks. You do start to see some more meaningful differences when putting the CPU under load for extended periods of time, but the difference still isn't enough to justify an entirely different line of devices. Clearly the effect of active cooling on RISC processors isn't the same as it is on CISC processors... at least when it comes to Apple silicon.

Based on the fact that the only major update to the 2022 MacBook Pro 13 was the use of the M2 processor, we think Apple might be thinking that actively cooling its entry processors might be more work than it's worth. So if you've got your heart set on a 2023 MacBook Pro 13... we reckon you're lining yourself up for disappointment. ■ **Joel Burgess**



Apple M2 CPU performance/ power graph against Intel Core i7-1255U CPU using Apple selected benchmarks.

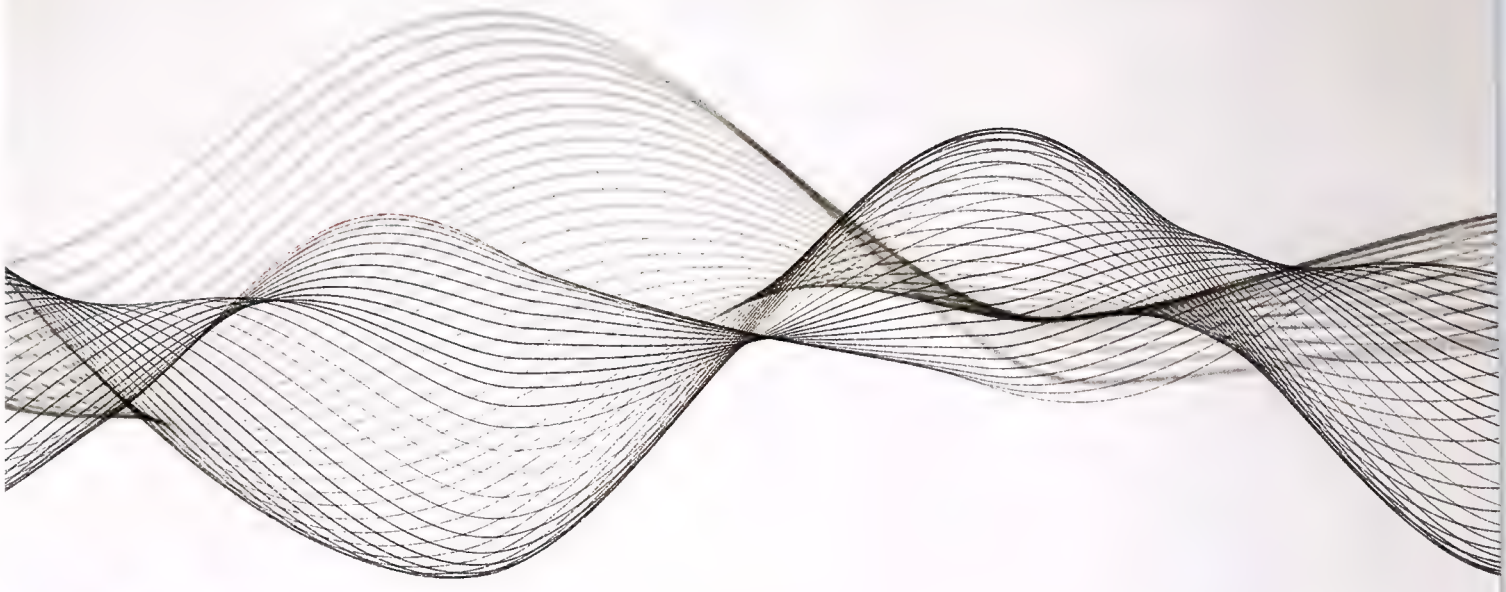
© Apple

Joel is one of the senior journalists on *APC* magazine and apart from being the resident laptop, monitor and fitness tech geek, he's also pretty into surfing his local Sydney beach breaks when he's not in front of a screen.

TWO BITS

Wi-Fi 7 is coming to supercharge your network

Smarter and faster Wi-Fi is coming in 2023, but don't rush out to upgrade.



Chris has been elbow deep in PCs since before the turn of the millennium, and he wouldn't have it any other way.

It seems like Wi-Fi 6 and 6E have hardly established themselves in the market yet. But wait! Here comes Wi-Fi 7! Wi-Fi 7, also known as 802.11be is set to become the de facto next generation wireless networking standard.

Wi-Fi 7 is being designed to cope with the ever higher demands of modern bandwidth hogging devices. Support for technologies such as untethered AR and VR, gaming, and 8K media streaming and a greater number of simultaneous connections are among the primary design goals. Add to that lower latency, dynamically optimised connections and enhanced security, and Wi-Fi 7 is well placed to take its place as the global Wi-Fi standard for the rest of the decade. Importantly, it remains back compatible with previous Wi-Fi devices too.

Getting a bit more technical, Wi-Fi 7 operates over more of the 6GHz spectrum, with 320MHz channels. Wi-Fi 7 introduces Multi-Link Operation (MLO) technology, which allows devices to simultaneously send and receive data over multiple channels to create a single aggregated connection. There's 4K QAM (Quadrature Amplitude Modulation) which allows signals to embed 20 percent more data than the 1024 QAM of Wi-Fi 6.

Ultimately, Wi-Fi 7 can allow theoretical connections of up to 46Gbps which is around 5x the maximum speed of Wi-Fi 6 and 13x faster than Wi-Fi 5. 16 x 16 MU-MIMO means you'll get up to 16 spatial streams. Does that mean routers with a lot of antennas? We'll have to wait and see.

However, it's not all rosy. Wi-Fi in the 6GHz spectrum (depending on transmitter and receiver capability) isn't well suited to longer ranges, meaning large households may require mesh networks or repeaters for high quality coverage. So, if you're an early adopter planning to build a Wi-Fi 7 network that covers a large space, you'll have to wait for appropriate devices, or spend a lot of money.

> "Wi-Fi 7 can allow theoretical connections of up to 46Gbps."

Wi-Fi 7 has yet to be officially certified. It's expected sometime in 2023, with devices to follow in the second half of 2023. If its introduction is anything like that of Wi-Fi 6 or 6E, then the first devices are likely to be on the client side. Things like routers and access points may not launch until 2024. Even now, Wi-Fi 6E routers are uncommon despite being widely supported by laptops, smartphones and motherboards.

Though the standard is still in the development stage, Intel and Broadcom recently held a briefing where it demonstrated interoperability between Wi-Fi 7 devices, in this case, an Intel laptop and a Broadcom access point. The demonstration was very simple, consisting of three laptops equipped with Wi-Fi 6, 6E and 7. The screens showed three software speed dials. It's hard to get too excited about that, but assuming the data was accurate, Wi-Fi 7 is looking good.

Assuming the provided data was accurate, the Wi-Fi 7 equipped laptop achieved 5Gbps, double that of the 6E laptop and five times that of the Wi-Fi 6 laptop. That's a nice improvement, but the main takeaway from the demonstration is that Wi-Fi 7 development is at an advanced stage.

As someone who requires fast network access for transferring large game libraries from a NAS, I welcome faster networking and will be happy to consider ditching the cable once next generation Wi-Fi becomes available. But don't rush out from day one. It'll be a couple of years before Wi-Fi 7 becomes a truly hot topic. ■

Chris Szewczyk

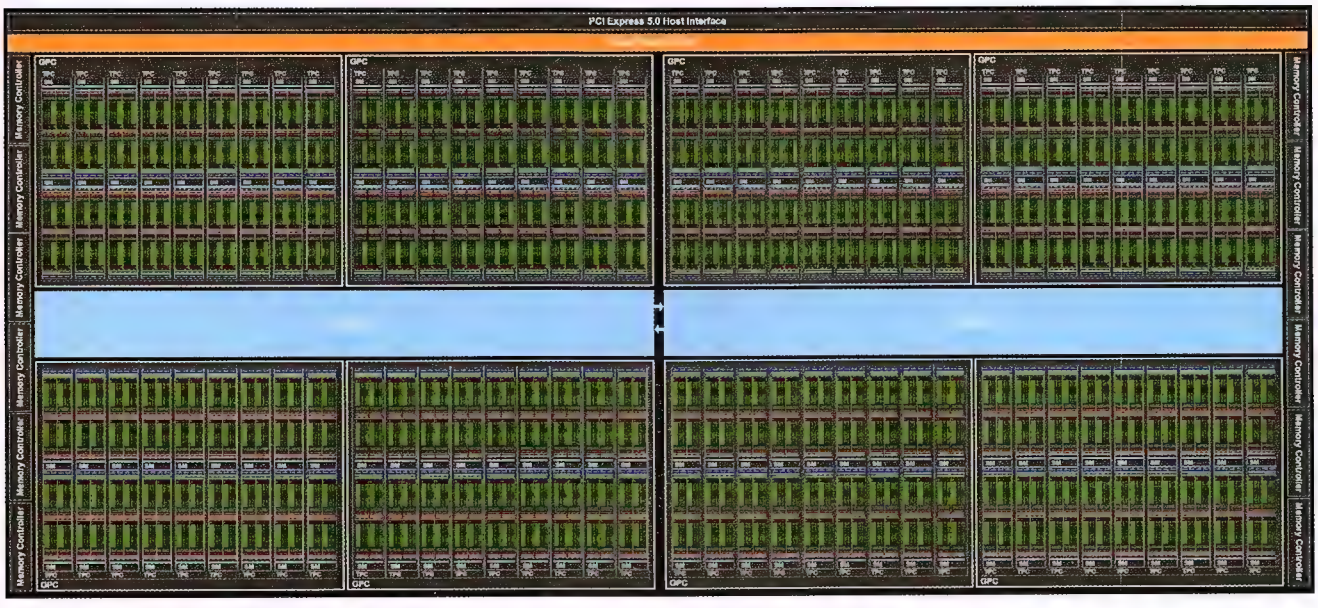
Look for this logo when Wi-Fi 7 products start to arrive.

© Getty

TECH TALK

The killer card

Nvidia's monstrous AD102 is on approach.



Will it be the RTX 4090 Ti, or is a new Titan in the works?

Word on the street is that we could see Nvidia's Ada Lovelace GPUs launch in the next few months. Nvidia isn't saying much, but the number of leaks is a sign the hardware is nearing completion and may be getting into the hands of early testers and add-in card partners. The latest rumours, if true, indicate the ultimate Ada graphics card will be an absolute monster.

Many of the core specs haven't changed much since the Nvidia hack earlier this year. We're expecting a GPU built on TSMC's 4N ("4nm Nvidia") custom process node, similar to that already being used for Hopper H100. Like the H100, the AD102 chip will have eight Graphics Processing Clusters (GPCs), with 18 Streaming Multiprocessors (SMs) per GPC, and 128 FP32 CUDA cores per SM. That yields a maximum configuration of 18,432 CUDA cores.

By way of comparison, the current RTX 3090 Ti with the full-fledged GA102 GPU only has seven GPCs, 84 SMs, and 10,752 FP32 CUDA cores. Of the potential 144 SMs, the top model will supposedly have 142 enabled, giving 18,176 shaders. Or put another way, AD102 will have up to 71 percent more shader processing cores than GA102.

The top-tier solution will come with up to 48GB of 24Gbps GDDR6X memory – double the VRAM of the RTX 3090 Ti, with 14 percent higher clocks. As I said, none of this is new information, but then we get to the real kicker. This performance king will come with two of the new 16-pin PCIe 5.0 power connectors, each of which can provide up to 600W of power. No, we won't be getting a 1200W graphics card – at least we hope not! – however, there are reports that the top SKU could be rated for 800W of power consumption.

Even if such a card can double the performance of the current RTX 3090 Ti, that's a ridiculous amount of power for a single graphics card. It also illustrates once again the lack of efficiency scaling at the top of the performance stack. Double the performance and double the power? The only thing we'd be getting from TSMC's 4N process would be transistor density, which means power density would likely double as well. How in Hades would you even cool an 800W card?

Interestingly, the next step down from this beast of a graphics card looks far tamer. It will only have 128 SMs and 16,384 CUDA cores, 24GB of memory, and a TBP power rating of just 450W. Basically, it will land in the same power envelope as the RTX 3090 Ti while providing potentially 50 percent more performance.

We have to wonder if the 48GB card might mark a return of the Titan brand. The Titan RTX back in 2018 was the last time we saw a Titan, with the 3090 and later 3090 Ti filling that same niche with Ampere. Only certain professional and prosumer workloads tend to benefit from the 24GB on the 3090 series, so doubling down and moving to 48GB would be extreme for anything outside the professional space. Needless to say, a 48GB GDDR6X card with 99 percent of the AD102 GPU cores enabled won't come cheap. We should know more by next month.

Jarrod Walton ■

"No, we won't be getting a 1200W graphics card – at least we hope not! – however, there are reports that the top SKU could be rated for 800W of power consumption."

TRADE CHAT

Alas Intel?

Don't panic, it's not that bad...

Despite the building narrative of multi-modal catastrophe at Intel and a stock price that's tanked by about 35 percent in the last few months, the reality is that not much has changed. Most of Intel's current problems were baked in years ago.

At the risk of sounding smug, four months ago, I called it regarding Intel's Arc graphics woes. So, let's just say recent rumours that Intel is seriously evaluating whether it should nuke the whole sorry saga aren't exactly surprising. But here's the thing. Arc isn't Intel's core competence. Intel did not bet the farm on Arc. Should Arc fail entirely, it would be costly and embarrassing, but it's not even nearly an existential issue. It's a bet gone bad.

Another bet gone bad, of course, is Intel Optane and the clever 3D XPoint non-volatile memory tech that underpinned it. Announced in 2015 and first productised in 2017, it's now officially dead. That's a great pity for both Intel and the PC given that Optane was the step-change over NAND flash memory that we'd all been waiting for. But it proved far too expensive. And Optane wasn't Intel's core competence, either.

Intel's most recent earnings are down a scary 22 percent over the same period in 2021. Add in rumours of Meteor Lake delays and it's easy to understand why some observers think the wheels are coming off. Meteor Lake, of course, is Intel's next-but-one CPU architecture, a radical new modular design using a mix of next-gen Intel manufacturing tech and chiplets farmed out to Taiwanese mega-fab TSMC. Look closer, however, and it is apparent that little of this is unexpected. And for now, it's not hugely worrying.

As Intel's CEO Pat Gelsinger himself has pointed out, Optane is merely one of six business units the company has shuttered or sold since his arrival, including the offloading of its drone business to Elon Musk's brother and the sale of its entire SSD operations to SK Hynix. Moreover, it was always going to take years to fix the big problem, namely Intel's manufacturing technology.

Delays in moving from 14nm to 10nm are at the heart of Intel's problems, not Optane or Arc. What Gelsinger, and therefore Intel, cares about is its so-called IDM 2.0 strategy. That involves a two-fold commitment to remain a cutting-edge chip manufacturer and therefore not offload or shut down its chip fabs, and to take that commitment a step further and open its doors to customers. In other words, make chips for third parties in Intel fabs.

If you measure Intel's success by that self-imposed IDM 2.0 metric, it's obvious that neither Optane nor Arc matter all that much. Indeed, the Arc project predates Gelsinger's premiership. So if Arc does blow up, it won't reflect on his strategy at all. Equally, according to Gelsinger, Intel is not expecting to regain its leadership position in terms of chip manufacturing technology until its 18A node comes online in 2025 or 2026.

So, the Arc project does look like a bit of a disaster. Intel's revenues aren't pretty. The cancellation of Optane is disappointing. But Intel's fortunes were always going to take years to turn around. It won't be until at least 2025 that the impact of Gelsinger's tenure will become clear. If by then the 20A node is still vaporware and Intel hasn't scored any major customers for its fabs, then OK, the strategy really is failing. Until then, don't panic.

Jeremy Laird ■

Six raw 4K panels forbreakfast, laced with extract of x86... Jeremy Laird eats and breathes PC technology.

"Intel's most recent earnings are down a scary 22 percent over the same period in 2021."

Will Intel's Arc cards be seen in actual retail packaging in lands beyond China?

Intel CEO Pat Gelsinger hasn't been afraid to make tough decisions.

The mouse that never got away

Jon Honeyball can't quite put his finger on why Excel on a Mac is so very different to Excel on a PC.

The history of the computer user interface is long and complex, but let's boil it down to one pivotal moment: the arrival of the graphical user interface. Suddenly, we needed a way to move a pointer around the screen.

Which brings us to touchscreens. These were universally awful until capacitive panels came along, together with the software behind it to work out where the centre of your finger should point. At a literal stroke, we moved from a pixel-perfect mouse world to a statistically calculated pointer.

But something was afoot with laptops. The need to carry a mouse around was always going to be clumsy, as were early "solutions" such as integrated trackballs, and nothing quite worked until the work around touchscreens merged with touch panels to bring us trackpads. Originally tiny, they grew massively both in terms of physical size and capability. Masking palm pressure was another key breakthrough that made larger trackpads possible.

Without even realising, I stopped using a mouse many years ago. This was mostly driven by my shift aware from desktop computers to laptops, but also by the rise in capability of the trackpads that Apple was fitting to its high-end laptops. Getting the responsiveness of this, which was a combination of hardware and software heuristics, must have taken a huge amount of work. And you can tell how carefully it has been thought out by the natural way in which it just works.

Now, I spend an unhealthy amount of my life in Excel. Most every time I use it, I curse and ask the Gods to bring back Lotus Improv. On my NeXT computer, please. But Excel on Mac, despite the many flaws of Microsoft's Office software on the Mac, works well. So why was using the Big Daddy version of Excel, on Windows 11, so awful?

What do I mean by awful? Moving around the spreadsheets was clumsy. Selecting items hit and miss. This wasn't related to the unholy mess that are the random differences between Excel for Windows and Excel for Mac: this was fundamental. I decided something had gone very wrong with the Dell, so spent an hour ensuring all drivers were installed, firmware updated and everything scrubbed clean. To no avail, my productivity had fallen through the floor.

In desperation, I turned to the excellent Logitech MX Master 3 mouse and paired it to the computer. Within moments, calmness returned. This was how Windows, and Excel for Windows, was supposed to be used. The Dell trackpad, decent though it is, simply wasn't up to the standard that my fingers had come to expect. No amount of tweaking could fix this problem.

Just for giggles, I fired up the Logitech MX Master 3 For Mac (yes, it is a separate and distinct device) and tried that on my 5K monitor connected to the Mac mini on my desk. It just felt wrong, and the languid and fluid operation of the Apple trackpad was gone, replaced by a lovely but clunky mouse sporting too many buttons. I will keep the mouse on my Mac mini desktop for the time being, but I can't see it being a keeper. For my Windows 11 based Dell XPS? In a move that turns the clock back 30 years, my computer bag now has to carry a mouse with it at all times.

> "I spend an unhealthy amount of my life in Excel."

Jon Honeyball ■

Jon Honeyball still remembers having to clean his ball.

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FUTURES

WE EXPLORE THE TRENDS AND TECHNOLOGIES THAT ARE SET TO SHAPE THE FUTURE

The VX4 will take off from the "Living Lab" vertiport.

Flying cars are ready for take-off – *almost*

Electric aircraft will be tested at some European airports in 2024, assuming the technology is ready and approved, with Australia set to follow. Nicole Kobie offers a fly-by of the project.

Flying cars are set for take-off in in Europe soon, and we'll all be watching closely as Australia shouldn't be far behind, with regional airline Rex hoping to begin testing these machines by 2024. And they're not flying cars, but electric aircraft.

At this year's Farnborough Air Show, a host of organisations including Virgin Atlantic, Atkins and Vertical Aerospace unveiled the Advanced Mobility Ecosystem Consortium (AMEC), which will spend a $16 million grant from the government to set up a trial of electric aircraft between Heathrow, London City Airport and Bristol beginning in 2024. "We're hoping to prep the industry for as close to commercial operations as we can," said James Richmond, head of advanced air mobility at Atkins, the company overseeing the trial.

The trial will see two test flights in 2024: one between Bristol Airport and an unnamed rural airfield, and a second between the company's own hub north of London and Heathrow Airport.

The media coverage crowed that these will be the first flying car trials in the UK: "Farnborough could be hailed as the start of the sky taxi," claimed *The Times* – and no wonder, as headlines with "flying car" are certainly more eye catching than "electric plane" (that's why we've used it, after all).

But you won't hear the consortium companies say that phrase in the AMEC launch announcement. Instead – with the notable exception of one government spokesperson referring to "air taxis" – the consortium partners are using the less sexy industry terms, referring to the project as advanced air mobility or urban air mobility, and the vehicles as eVTOLs, or electric vertical take-off and landing aircraft. Indeed, this is a battery-powered evolution from aircraft rather than cars. What's impressive isn't that they fly, but that they do so without any operational emissions.

"It's not a flying car. It's not an air taxi. It's going to be a scheduled air service."

It's perhaps time for the flying car moniker to be dropped. "It's one of my pet peeves," said Sergio Cecutta, an analyst at SMG Consulting, which tracks the advanced air market. He says that when people see the vehicles in person, they realise two things: they're big, and they're aeroplanes. "I think that this flying car moniker was good to get it started, but it's going to be a disservice if people think this is a flying car," he said. "It's not a flying car. It's not an air taxi. It's going to be a scheduled air service."

Testing the future

The AMEC trial will have just two flights, as well as a third simulated between Bristol Airport and London City Airport. The AMEC project is using the VX4 made by Vertical Aerospace,

based in Bristol. But the aim of the trial isn't to test the aircraft itself, as that will require certification from the CAA before it can take flight, which Vertical Aerospace expects to happen in time for the 2024 launch.

Instead, as the name of the consortium suggests, the member organisations are hoping to build everything that's needed for such aircraft to take to the skies: air traffic control, ground infrastructure and security protocols. Not forgetting the other supporting businesses that are necessary around any transport mode. It will all be overseen by aerospace engineering consultancy Atkins and managed by tech quango Connected Places Catapult.

"Advanced air mobility is really now at a point where a systems-thinking approach is required," said Richmond. "There's a complex set of different subsystems, whether that be the vehicle, infrastructure, air traffic solutions, integration with current transport modes, operations with the public – there are so many different facets."

He added: "If we don't now apply a systems engineering approach to that, and really start to make sure that those interfaces come together... we risk becoming siloed in the development."

Virgin Atlantic will operate the flights, using Vertical Aerospace's VX4 eVTOLs. NATS, an air traffic control company, is helping to build a system to manage electric aircraft, while Cranfield University is developing a scheduling system for airspace and vertiports. One key part of the infrastructure is battery chargers. For that, Warwick Manufacturing Group at University of Warwick has teamed up with Vertical Aerospace to develop fast-charging systems as well as a smart diagnostic system.

The heart of the project is the "Living Lab", a vertiport that will be built at an as-yet undisclosed location north of London. Built by Skyports, the Living Lab will act as a testbed for the aircraft as well as ground operations and passenger experience. Duncan Walker, CEO of Skyports, said in a statement launching the consortium: "Just as airports are critical to commercial airplane travel, vertiports are critical to AAM."

Top: It might look like a posh Uber, but the VX4 is no air taxi.
Above: Vertical Aerospace's VX4 should be ready to take to the skies by 2024.

The Living Lab will be up and running a full year ahead of the flight demonstrations, in order to test the different technologies and procedures ahead of time, ensuring the ground operations, electric charging and passenger journey all make sense. "It's a sandpit, where we can all work together and collaborate," Richmond said. "The Living Lab really provides the environment for us to collaborate physically and digitally."

That's necessary as the technology for each bit of the process is still being built. "Each piece of the puzzle is being developed at the same time... there's no one dominant solution or technology in any of these fields," said Richmond. "That's why it's such a complex and challenging project; it's not just about stitching the pieces together, it's about stitching moving parts together."

Ready for take-off?

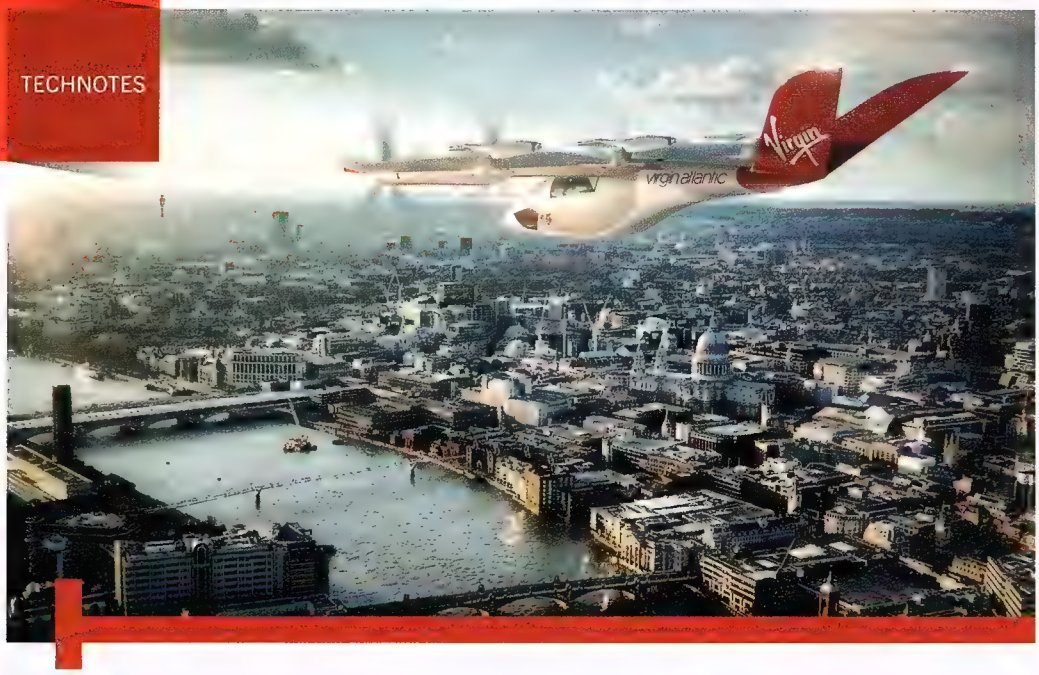
Of course, step back for a moment and it's merely two flights. The first is the flight from Bristol to a rural airfield. "It's one of the easier use cases to test, and we won't be building any infrastructure for that," Richmond explained.

The second test is between Bristol Airport and London City Airport, but it will be limited to a digital simulation to test how such aircraft will cross through different flight zones above a city. Led by NATS, it will test ground operations physically before passing off a virtual aircraft to the simulator.

The test is simulated because the aircraft won't yet be certified, and there's no need to push the envelope with safety, explains Richmond. "Given the primary mission is to test crossing the different classes of airspace, it's not something we need to do physically."

As Cecutta notes, the VX4 won't yet be certified, but will be allowed to fly in some circumstances to get airtime to win certification. "You can fly it over specific corridors," Cecutta said, but not over crowded cities.

The project's capstone



VERTICAL AEROSPACE'S VX4

Forget about flying taxis. Even if one day you can hail the VX4 from an app, this electric jet has little in common with your Uber driver's Toyota Prius.

To start, the VX4 has a top speed of 325km/hour and Vertical Aerospace claims it can cover a range above 160km – the distance between Heathrow and Bristol Airport. It can carry five people, including the pilot.

The carbon-fibre VX4 uses the same control system as Honeywell's F-35, with the aim of making it simpler to fly than standard aircraft, and has an electric drivetrain developed alongside Rolls-Royce. Across its 50ft wings, the VX4 has four rotors at the front and four at the rear that tilt 90° into position for lift during take-off, before shifting into flight position to cruise like a standard aeroplane.

Battery operated, it's much quieter than a helicopter – 45 decibels when cruising and 60 decibels when hovering – and has no operational emissions.

Alongside passenger flights, Vertical Aerospace sees the VX4 being used for cargo as well as medical evacuations and maintenance operations, working with UK company Babcock to develop such applications.

The aircraft must be certified by regulators first, with the company hoping to win full approval by 2025. The first flight test of the VX4 prototype was set to happen this summer, and Vertical Aerospace already has 1,350 pre-orders for the aircraft, worth $7.7 billion, suggesting a sales price of around $6.8 million.

That includes 150 aircraft optioned for order by Virgin Atlantic. "We are building the best industrial and commercial partner ecosystems and are progressing in Britain with our UK launch customer, Virgin Atlantic," said Andrew Macmillan, director of strategy of vertical aerospace, in a statement.

Richmond emphasises, is the flight into London Heathrow in September 2024. "We are calling it an end-to-end demonstration of the entire commercial operation from our site on the outskirts of London into Heathrow," he said.

That will include passengers arriving and being processed by security and check-in agents from Virgin, but they won't actually board the aircraft as the VX4 will still be uncertified for passenger flights at that stage. Instead, alongside the pilot, there will be test engineers on board to represent the passengers and monitor the flights.

The trial may sound small, but Cecutta says that it's the right way to proceed. "It's good to work out all the kinks in the system before the public is involved," he said. "It's better to solve your problem behind closed doors... it's good to have this dress rehearsal because we've never done it before."

What's next?

After the tests, what happens? "We believe this is going to accelerate the commercial readiness for the UK," said Richmond. "It will provide a blueprint that others can learn from, but our objective is to get ready for commercial operations."

But there's more to making advanced air mobility work than what's being tested in this project, Richmond admits, saying it's important to consider how to scale the industry and how to maintain aircraft. Because this is an entirely new form of transport created in the digital era, he believes digital twins will be used to manage maintenance and repairs. And for such aircraft to be truly sustainable, principles of circular economy should be considered to allow parts to be reused. "We should reuse, recycle and reinvent vehicles again and again," he said. "That will also bring the price point down because it gives the asset a more valuable life."

The first commercial flights will begin in late 2025 or early 2026, but will be limited in number, Richmond predicts. "Then I think there'll be a scaling phase for advanced air mobility up to 2030," he added.

Cecutta agrees. "The interesting thing about Farnborough was the amount of news coming out about advanced air mobility," he said. Vertical Aerospace rivals Supernal and Eve both had cabin designs on show, while Joby, one of the market's leaders, didn't attend the show but still put out announcements about certifications. "We're getting close to the real deal."

Future flight

The type of trips being trialled hint at the potential uses and business cases for electric aircraft. While Vertical Aerospace also has partners working on developing the VX4 for cargo and emergency uses – quieter and cheaper than a helicopter, it could be ideal as an air ambulance – the AMEC trial focuses on passenger travel.

That could be linking up airports for connecting flights. Right now, getting between Bristol Airport and Heathrow is a three-hour journey on buses and trains. The other test flight is between Bristol Airport and an undisclosed rural airfield. The aim there is to show how electric aircraft could help link rural communities to cities, which Richmond believes will be among the first use cases, as rural airfields already exist and such routes have real social value.

Ensuring that the future of air mobility doesn't merely supply a traffic-skipping route between the Cotswolds and the City is key. "We need to be thinking about how we make this a transport mode for as many people as possible, and I believe the key to that is ensuring that we design a system that can be scaled," Richmond said, adding that will also help ensure that prices stay accessible.

"Advanced air mobility offers huge benefits in how we move people around our cities in the future," concluded Richmond. "There are so many benefits, we can't afford not to get this right the first time." ■

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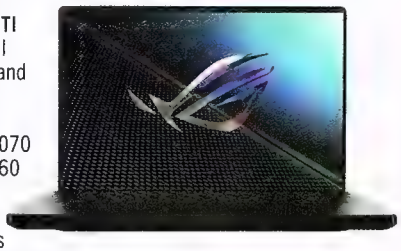

2022 will see an update for all mainstream gaming laptops, and Asus is first to jump in with a 12th gen Core i9 CPU to give 16-core support to the RTX 3070 Ti graphics (a Core i7/RTX 3060 variant costs $2,999). While battery life is only average at around six hours, this laptop's final triumph is fitting a gorgeous 16-inch screen into such a compact chassis.

$4,499, asus.com/au

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From $2,399, lenovo.com/au

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$5,799, asus.com/au

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$3,499, asus.com/au

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$3,750, dell.com/en-au

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$2,209, hp.com/au-en

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$2,389, lenovo.com/au

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$2,369, anz.dynabook.com

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$1,213, asus.com/au

NEW ENTRY

HP ELITE DRAGONFLY CHROMEBOOK

This is quite simply the best business Chromebook around, although at the time of writing we're waiting for units to hit the market. Build quality is stunning, as is this 13.5in convertible's 1.3kg weight.

$TBA, hp.com

LENOVO IDEAPAD DUET

The Chromebook answer to Microsoft's Surface tablets, this is a seriously versatile device – albeit not the speediest (although we never found it to be painfully slow while carrying out everyday tasks). For this price, and with a 16hrs 14mins battery life, the Duet is a great choice.

$447, lenovo.com/au

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apple.com/au

APPLE IPAD (2021)

Apple performs its usual trick of upgrading just enough to keep the iPad affordable and up to date, without treading on the toes of its more luxurious stablemates. The big bezels remain, but a faster processor, more storage and improved camera all add to its appeal.

From $449, apple.com/au

SAMSUNG GALAXY S8 ULTRA

The Samsung Galaxy Tab S8 Ultra is an enormously impressive tablet. It makes a fantastic first impression with its gorgeous screen and thin body, and is great for multitasking. If you want the best Android tablet going, there's no question at all that this is it.

$1,598, samsung.com

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$849, philips.com.au

EIZO FLEXSCAN EV2480

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$699, eizoglobal.com

DAHUA DHI-LM28-F420

This affordable 4K monitor might not offer much in the way of menu options or high-end gaming perks, but it offers impressive resolution and colour for ally pay.

$269, dahuaaustralia.com.au

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EIZO COLOREDGE CG319X

CREATIVE MASTERCLASS, $7,119

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$7,119, eizoglobal.com

BENQ PD2725U

By no means a cheap 4K 27-inch monitor – unless you compare it to the Eizos – but it marries all-round quality with ease of use thanks to a puck that allows you to quickly move between settings. You can even daisy chain a second Thunderbolt 3 monitor for a monster setup.

$1,799, benq.com

EIZO COLOREDGE CG279X

Designers who need to work across different disciplines will love how easy it is to switch between the Adobe RGB, DCI-P3 and sRGB colour spaces using the Eizo's fantastic OSD. It's certainly not cheap for a 27-inch 1440p monitor, but it's packed with quality.

$3,095, eizoglobal.com

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$299, epson.com.au

CANON PIXMA PRO-200

Yes, it's big and it's expensive – and you don't even get a scanner – but the Pixma Pro-200 means that you can print A3 photos with glorious colour accuracy and detail. If you're after an office workhorse, look elsewhere, but it can't be beaten on photo quality.

$809, canon.com

BROTHER MFC-J4540DWXL

Home workers will love this inkjet all-in-one. It combines an incredible range of features with all the connectivity you need and extreme ease of use. Output quality is fine, it offers the best cloud support around and the high-capacity ink pack could keep you going for years.

$420, brother.com

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$599, synology.com/au

ASUS RT-AX82U
The impressive RT-AX82U punches well above its price when it comes to raw Wi-Fi 6 performance and includes a fistful of useful features – such as an ultrafast 20Gbits/sec USB connector, outbound VPN support, site-blocking and a host of parental controls.
$320, asus.com/au

HUAWEI WS7200
This affordable Wi-Fi 6 router delivers consistently fast wireless speeds, broad coverage and a modest speed boost for newer hardware – and the Router 3 has a cute design too. If you need more range, you can pick up a second unit to use as an extender.
$120, huawei.com

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NEW ENTRY

TP-LINK DECO XE75 AXE5400
SUPERB WI-FI 6 MESH
Offers the simplicity, speed and range most people want from a mesh system. While it's expensive, nothing else offers the plug-and-play simplicity, speed and range afforded by the Deco XE75.
$999, tp-ink.com

TP-LINK DECO X20
The price below isn't a typo: the Deco X20 makes it possible to upgrade your home network to Wi-Fi 6 – as well as manage its security – for the price of some standalone routers. The included HomeCare functions are also a great bonus for households where lots of devices are fighting over the bandwidth. **$199, tp-link.com**

ASUS ZENWIFI AX
The interface and design certainly aren't the prettiest (the nodes look like mini space heaters, while the charcoal version is straight out of the 1980s), but if you're after strong performance, great features and plenty of expansion potential, the ZenWiFi AX is a compelling prospect.
$949, asus.com/au

NAS SERVERS

QNAP TS-130
SIMPLE HOME NAS
An above average CPU and RAM combo, solid features and affordable price make the QNAP TS-130 worth considering. Alternatively there's the two bay TS230 which features the same CPU, with 2GB of RAM, dual drive bays, and an extra USB port on the front for a modest $50 price increase.
$250, qnap.com

ASUSTOR NIMBUSTOR AS5304T
This is a hugely powerful four-bay NAS that will be overkill for most people – not just due to its speed but also its slightly intimidating user interface – but techies and gamers should investigate the Nimbustor AS5304T for both its speed and flexibility.
$799, asustor.com

SYNOLOGY DISKSTATION DS1522+
At $1,199 it's not cheap but factoring in the software means it's great value. Though some internal silicon may lack headroom, this is still a well-featured, expandable NAS with fantastic software. The best part is the DSM software.
$1,199, synology.com

SECURITY SOFTWARE

F-SECURE SAFE
F-Secure concentrates on the basics: faultless protection with minimal impact on your system's performance – for a low price.
1-3 PCs, 1yr, $99.99, f-secure.com

ALTERNATIVES

NORTON 360
Consistently on the podium in our group tests, and loaded with an abundance of genuinely useful features, including a VPN and generous cloud backup.
1 PC, 1yr, $79.99, nortonlifelockpartner.com

AVAST FREE ANTIVIRUS
For the second year running, Avast is our top pick for free antivirus software – it's simply lighter on its feet than Microsoft Windows Security, whilst offering fewer false positives.
Free, avast.com

VPNs

NORDVPN
NordVPN provides consistent and fast speeds, serious security, great support for video-streaming services and some cost-effective subscription rates.
$59 per year, nordvpn.com

ALTERNATIVES

PROTONVPN
ProtonVPN provided one of the best free offerings of all the VPNs in our group test, including unlimited data, but upgrade to benefit from even faster speeds and many more options.
Free, protonvpn.com

SURFSHARK
A strong rival to NordVPN, especially if you're willing to commit to its two-year contract. It's fast, cheap and a fine choice for people who like to switch to US streaming services.
$66.34 for one year, surfshark.com

PASSWORD MANAGERS

BITWARDEN
Bitwarden has a huge advantage: it's free. It isn't as slick as some paid-for rivals, but it can sync passwords across all devices for no extra charge. **Free, bitwarden.com**

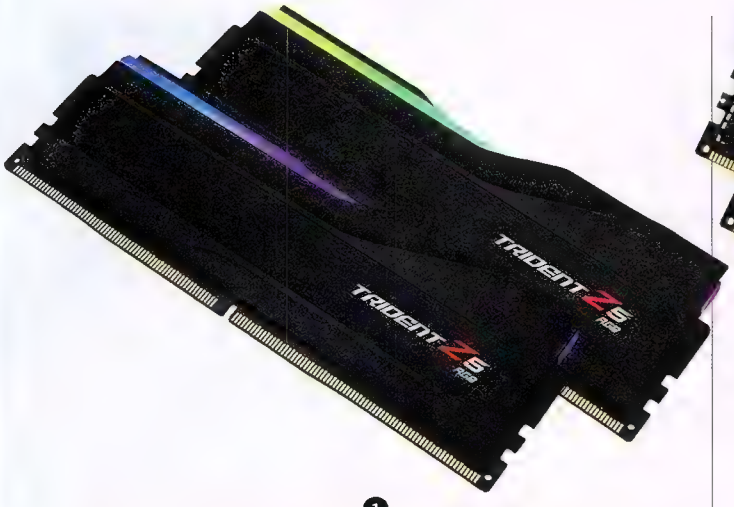
ALTERNATIVES

DASHLANE
A manager that's ideal for beginners, and it even builds in an unlimited (if basic) VPN service. Note you may prefer to buy the Family plan ($60 per year) as this extends the service to six people.
$55.99 per year (Premium), dashlane.com

1PASSWORD
1Password is targeted at technically minded users who are looking for the last word in security. It even offers a Travel Mode that may ease your mind if surrendering your phone to customs officials.
$54.99 per year (individual), 1password.com

The top five DDR5 RAM

After a couple of years of patiently waiting on the sidelines, DDR5 RAM is about to enter the limelight. It's already supported by Intel's 12th generation chips (although they also work with DDR4), but AMD's incoming Socket AM5 platform is going to require the newer memory. At the same time, prices have steadily been coming down, meaning you don't have to worry about remortgaging your house to get on board. So, if you're destined for DDR5, these are the sticks to go for.



1

G.SKILL TRIDENT Z5 RGB 2X16GB DDR5-6000MHZ CL36

If you want it all, this is the kit to go for. G.Skill's kit is crazy fast, has great timings, and features subtle RGB lighting. This Trident Z5's 6000MHz speed and 36-36-36 timings hit the sweet spot for high-frequency and tight timings, plus this kit doesn't cost much more than a 5200MHz kit. It's available in both black and silver finishes and non-RGB versions if you prefer the stealth look.

$569, www.gskill.com.

2

CRUCIAL 2X32GB DDR5-4800 CL40

If memory capacity is your priority, then Crucial has you covered. 64GB DDR5 kits are actually pretty hard to come by as the Intel memory controller struggles with high-density configurations. Thankfully, this kit is fantastic value for money, as it doesn't cost too much more than the 32GB kits listed here. Thanks to its size, this Crucial kit is future-proofed for many years to come.

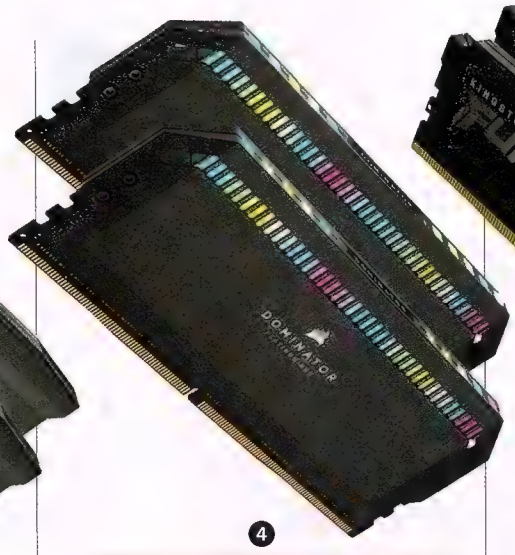
$459, www.crucial.com

3

CORSAIR VENGEANCE 32GB DDR5-4800MHZ

If you're an average gamer, you probably want 32GB of fast RAM, but not so fast it breaks the bank. If so, this is the kit for you – it's perfect for a budget B660 motherboard, it tolerates overclocking if you're OK playing with the voltages, and it runs cool under load. It's not RGB, but it is low-height, making it a great match for larger CPU coolers.

$379, www.corsair.com



4

CORSAIR DOMINATOR PLATINUM 32GB DDR5-5200 C38

Corsair's Dominator brand has built a reputation for quality and, with its weighty heat spreaders and excellent 5200MHz speed with 38-38-38-84 timings, the C38 maintains that. This kit is all about the RGB lighting, with full integration with Corsair's iCUE system – but it's a tall kit that may block some coolers.

$359, www.corsair.com

5

KINGSTON FURY BEAST 32GB DDR5-6000 C40

Kingston's kit may feature the words 'Beast' and 'Fury' in the title, but it's actually rather subdued and stealth-like. Those words apply to the performance, particularly the high-frequency 6000MHz speed, while the timings are also good. The real draw of this fast memory kit is its excellent price, with the bonus that it has good heat spreaders.

$369, www.kingston.com

TECHNOTES

Gadgets

Objects d'lush

❶ FITBIT SENSE 2

Live happier and healthier with the best wellness wearable around.

$449.95 | fitbit.com

Fitbit has updated its flagship health tracker with new sleep, stress and activity tracking to help you get a more nuanced picture of your overall wellness. Using its enormous dataset of all-day heart rate tracking, Fitbit is able to get a better understanding of your stress levels throughout the day and can provide timely insight on the impact of intense emotions and offers proactive solutions for improving your health and mental wellbeing. This combines with the advanced sleep tracking and a more diverse set of exercise modes to be one of the best health tracking wearables around.

❷ TCL NXTPAPER 10S

A tablet that's also an ereader seems like a no brainer.

$TBC | tcl.com

There's no shortage of e-ink devices providing paper-like experiences for reading books and drawing, but how amazing would it be if your tablet was capable of reproducing pages as if they were printed on paper? This seems to be the premise for TCL's Nxtpaper 10s tablet, which offers built in reading modes and a tactile capacitive screen that feels and looks just like paper. The device has a lightweight MediaTec processor, 4GB of RAM and is capable of running Android 12 so you should be able to do most of the things you'd expect from a modern tablet. You'll also get 64GB of onboard storage, a 8000mAh battery and a MicroSD card slot.

❸ SATECHI USB-C 4-PORT GAN CHARGER

One hub to charge them all.

$199 | satechi.net

Tech is still a way off offering inexhaustible power and if you're anything like APC's writers you have plenty of tech that needs constant rejuicing. Satechi have invested in developing a DC charger that uses Gallium Nitrate to charge devices faster without overheating. This novel material allows the 4-port charger to share up to 165W of power delivery among the four ports to charge Ultrabooks like the MacBook Air at full 67W fast-charge, alongside three other power-hungry devices. The charger also offers leading temperature, current and voltage protection to ensure that your devices are never put at risk.

4 APPLE WATCH ULTRA

Apple's got a new flagship smartwatch that's ready for an adventure.

$1,299 | apple.com/au

Apple is intent on taking on some of the more serious smartwatches around these days with the new Apple Watch Ultra. The new flagship has a bigger screen wrapped in a 49mm titanium case that has 100m water resistance and stands up to rigorous military grade impact and stress testing. It's also got a screen that's twice as bright as the standard Apple Watch, but the battery is big enough to keep it running for twice as long with a runtime of 36 hours. All these upgrades combine with the 4G cellular, advanced GPS and a range of other health and environmental sensors to create a competent adventuring companion.

5 LEICA CINE 1

The ubiquitous lens manufacturer gets on the other side of the camera.

US$7,900 | leica-camera.com

If you know anything about photography you'll have encountered Leica's perhaps unparalleled reputation for creating precise lenses for various applications, so when the company announced that it's putting out a short throw projector it's worth listening. The Cine 1 is an ultra-short throw unit that can spit out a bright 4K resolution at 80 or 100-inches. The unit can produce up to 2500 ANSI lumens which is a long way off today's brightest TVs, and is even quite a bit duller than a HDR OLED TV, but many cinematic purists still prefer the image created by a projector, and you'll be hard pressed to find a better one than the Cine1.

6 GOPRO HERO 11 BLACK

2022 action cameras have plenty of reasons to go back to black.

$799.95 ($649.95 with GoPro subscription) | gopro.com/en/au

There's a few new devices from GoPro this season, so if you're an athlete trying to capture extreme sports then you'll probably prefer the more compact, screenless, $499.95 Hero 11 Black Mini. If however, you're looking for content creation capabilities, the Hero 11 Black Creator Edition comes kitted out with microphones, lighting, bigger batteries and the space to attach more mods and mounts for $929.95. For everyone else the Hero 11 Black is likely to be your weapon of choice offering a trusty screen in a super rugged package with an updated image sensor, HDR colour, and HyperSmooth 5.0 for $649.95.

GAMING LAPTOP

Acer Nitro 5

Acer's budget gaming beast has a new recipe to turbocharge your gaming experience.

■ $2,699 | online.acer.com.au

■ W11 Home; 15.6-inch IPS 144Hz display at 1920x1080 pixel resolution; Intel Core i7-12700H CPU; Nvidia GeForce RTX 3060 GPU; 16GB RAM; 512GB PCIe SSD; 54Wh battery (1h38min 1080p movie playback); 36 x 27.1 x 2.7cm; 2.6kg

Historically, we've loved the Nitro range of gaming laptops from Acer for their use of near end of season components to make competitive gaming rigs that were a little bit better value than what you might be used to. And while this year the Nitros are by no means the first Intel 12th gen gaming laptops to hit shelves, they're not quite as late as they usually are either. Unfortunately they also don't seem to be quite as budget conscious as they once were.

The 2022 Nitro 5 is a performance-first 15.6-inch gaming rig that is 2.7cm thick and weighs 2.6kg. This profile makes sense when you're looking at fitting it out with an Intel Core i7-12700H CPU, 16GB of RAM and a Nvidia GeForce RTX 3070 Ti GPU for $4,499, but it's super bulky if you're going to opt for the $1,899, i7-8GB-RTX 3050 GPU combo. You see, the 3050 and 3050 Ti GPUs on the two entry models can fit in Ultrabooks and even tablets like Asus's ROG Flow Z17 at less than half the weight and thickness. You pay more for them in compact form factors, but the biggest thing to consider is that because of the abundance of cooling architecture in the Nitro 5 they can actually put 75W of power through the 3050Ti , which makes them considerably more powerful than ultrabook models with the same GPU.

The model we were provided had a Nvidia RTX 3060 GPU so we weren't able to tell exactly how much of a performance bump you'll see on the 3050 Ti, but it should be in the ballpark of around 25 percent better than Ultrabooks running the same GPU. Even with the 3060, we were impressed by how our unit did. On The Division 2 at 1080p Ultra settings it managed to average 76fps and could get 100fps plus on less demanding titles. This makes it powerful enough to really utilise the 144Hz IPS panel it comes with. If you do opt for the 3070 Ti model you're looking at fps averages 30 percent higher again than the 3060's results here.

Intel's 12th gen mobile CPUs offer solid performance, so there's not much you won't be able to do when it comes to general work tasks and even demanding workloads, if you're planning on using it for that. Just don't expect to be able to be away from power for too long since this unit can only just make it through your average movie.

The Nitro 5 offers a MUX switch for those that can be bothered to dig into the NitroSense settings. This is apparently worth doing since some online reviewers have noted performance gains of over 17 percent by turning off Nvidia's auto-switching GPU software. If you really need better battery life, there's sense in having Optimus engaged, but under general usage conditions the screen cuts out for an annoyingly long time every time it switches GPUs, even if you are connected to power.

Keyboard, trackpad, interface options and network connectivity are all up to scratch and will satisfy any gaming and work needs you may have. The included Acer Care Centre software is useful for keeping your device healthy and if you're into E-sports then the included Planet9 social media software is a nice bonus feature for super competitive gamers.

	Acer Nitro 5	Acer Nitro 5 (2021)
PCMark 10 - Overall (score)	7,350	5,200
Max CPU Temperature (C)	97	95
1080p movie playback (HH:MM)	01:38	06:22
Cinebench R23 - CPU (Score)	14,402	7,320
3DMark Time Spy (score)	8,144	6,784
F1 2021 - 1080p Ultra (fps Av.)	132.78	101
CrystalDiskMark Read (MB/s)	6,481	1,880
CrystalDiskMark Write (MB/s)	3,963	1,718

A competent performance driven gaming laptop that lands at a fair price.

Joel Burgess

★★★★☆

GAMING LAPTOP

Asus ROG Strix Scar 17 SE

Asus is looking to make a mark on esports pros with its new king of the gaming ring.

■ $5,799 | rog.asus.com/au

There's no denying that the Strix Scar 17 is a beast. A laptop that's over 3kg is almost unheard of these days, but this gaming powerhouse is packing a top shelf Intel Core i9-12950HX CPU, a 175W Nvidia GeForce RTX 3080 Ti GPU and all the cooling architecture required to keep these powerful components from turning into a molten mess. We haven't actually tested anything with a GPU drawing this much power in some time, so it's unsurprising that it was a good 15 percent faster than any other laptop we had on file.

Translating this into meaningful metrics means that you can expect 100fps plus performance on basically any game using 1080p Ultra settings and more like 200fps plus on less demanding esports titles. That's well within the range to make use of the ridiculously fast 360Hz 17.3-inch monitor that Asus attached to the Scar 17 SE.

While there are some higher resolution screens on offer overseas, locally this is the only model available and comes with 32GB of RAM and a 2TB SSD for a total of $5,799. That's a pretty eye watering price tag for a laptop, but when you put it up against MSI's similarly specced GE76 for $7,499 it looks like an absolute steal.

Asus claims that the vapour chamber and thermal paste combo it uses in the Strix Scar 17 SE improves its cooling potential by 15 degrees which helps it to give users longer periods of boost speeds. It also aims to do this without causing the fans to ever breach a 40db-library-noise threshold and we didn't notice anything while testing that contradicts this.

While the display might not offer an ultra fast refresh rate and sub 3ms response time, it's actually pretty light on in other specs. The IPS display doesn't strive to meet a higher colour gamut than sRGB and can only output in 8-bit colour, so it's not going to be ideal for anyone hoping to play immersive games alongside their go to shooter or esports title. It does mean that while this monitor only offers Adaptive Sync rather than full Nvidia G-sync certification, it probably won't make much difference when you can't play in HDR colour anyway. Asus did engage Dolby to allow this device to at least stream HDR media, but it won't be true HDR by any means.

	Asus ROG Strix Scar 17 SE	MSI GE76 Raider (2022)
PCMark 10 - Overall (score)	6,893	7,618
Max CPU Temperature (C)	96	99
1080p movie playback (HH:MM)	04:04	05:08
Cinebench R23 - CPU (Score)	16,071	17,118
3DMark Time Spy (score)	13,064	11,247
The Division 2 - 1080p Ultra (fps Av.)	109	102
CrystalDiskMark Read (MB/s)	7,071	6,584
CrystalDiskMark Read/Write (MB/s)	5,004	5,085

■ W11 Home; 17.3-inch 360Hz IPS display at 1920 x 1080 pixel resolution; Intel Core i9-12950HX CPU; Nvidia GeForce RTX 3080 Ti GPU (175W); 32GB RAM; 2TB PCIe SSD; 87Wh battery (4h4min PCMark 10 Home Office Battery); 39.5x28.2x2.8cm; 3.1kg.

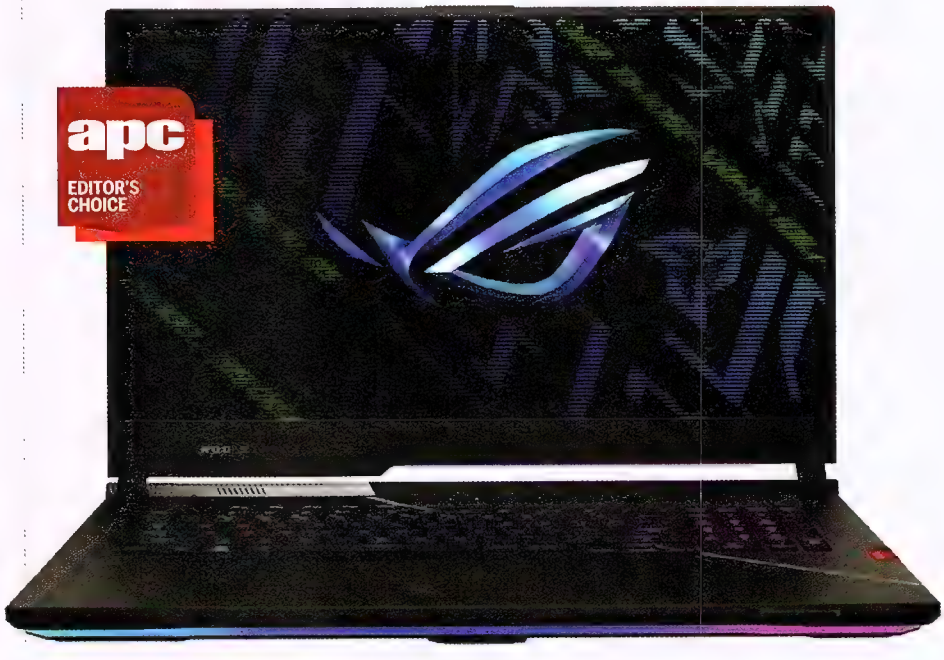
The audio is top notch with a solid array of Dolby Atmos speakers, Hi-Res audio capabilities and AI noise cancelling microphones, and the full size keyboard has everything you'd want in a gaming laptop with per-key RGB and a good arrangement of function buttons. WiFi 6E and 2.5GB Ethernet means you'll have the fastest network connectivity around and Asus's Armoury Crate gaming software offers excellent customisation options to ensure performance is top notch.

The battery life is a little better than some gaming rigs when you leave Nvidia Optimus auto GPU switching on, managing over four hours in light work benchmarks, but be warned that the auto switching GPU feature can be disruptive when moving through applications and has been shown to affect GPU performance.

An extremely high performance esports gaming laptop for a decent price.

Joel Burgess

★★★★½



ULTRAPORTABLE

Dynabook Portégé 40L-K

Is Dynabook's golden child good enough to take down the ultrabook giants?

■ $2,136 | anz.dynabook.com

The Portégé range from Dynabook is a little thinner, a little lighter and a little more premium than the Tecra devices that we've covered recently (*APC* 510). And with all those premium features naturally lead to a price tag to match... meaning that this device is taking on Apple's MacBook Air, Dell's XPS and a long list of other seriously competitive ultrabooks.

Let's touch first on what the Dynabook Portégé 40L-K does well. The first area that it's ahead is in its weight. At just 1,022 grams it's around 200g lighter than just about all the competition and it even manages to do this without making the shell out of cheap feeling plastic. The bezels and screen surround is a plastic sheet, but the rest of the chassis is wrapped in a lightweight magnesium case that maintains elegance, but adds a unique feeling of lightness.

Other than this battery life is also solid for a Windows based device. The 67Wh battery lasts around the 11 hour mark for both working tasks and 1080p movie playback. This puts it roughly in line with the Acer Swift 5, which is about four hours more than an XPS 13. It's worth noting that this is still a long way off Apple's M2 MacBook Air (*APC* 511) which can last around 19 hours.

So the Portégé 40L-K is a 14-inch clamshell non-touchscreen laptop that features one of Intel's 12th generation Ultrabook processors. The device we tested came with an i5-1240P CPU, 16GB of RAM and 512GB of storage for around $2,200. So while it might have a better battery life than something like the XPS 13, it's over $100 more for a similarly specced unit at full price, and could cost you more like $400 more when you factor in typical Dell sales prices.

	Dynabook Portégé 40L-K	Dell XPS 13 Plus
PCMark 10 - Overall (score)	5,109	5,125
Geekbench 5 - Multi-core (score)	9,252	8,594
Cinebench R23 - CPU (multi-threaded)	8,439	8,161
3DMark - Time Spy (score)	1,544	1,858
Battery life - 1080p video playback (h:min)	10h55min	6h6min
Peak CPU temperature (°C)	100	100
CrystalDiskMark Read (MB/s)	3,049	7,082
CrystalDiskMark Write (MB/s)	1,827	5,095

■ W11 Pro; 14-inch 16:10 IPS display at 1920 x 1200 pixel resolution; Intel Core i5-1240P CPU; Intel Iris Xe GPU; 16GB RAM; 512GB PCIe SSD; 67Wh Battery (10h 55min 1080p movie playback); 31.2 x 22.4 x 1.6cm; 1.02kg.

> "At just 1,022 grams it's around 200g lighter than just about all the competition and it even manages to do this without making the shell out of cheap feeling plastic."

Up against the MacBook Air, you are looking at forking out a similar price for comparable performance and while the Portégé is lighter, the MacBook Air is thinner, longer lasting, and has a dramatically better screen. So when you add all this to the fact that Dynabook is not exactly a well known brand these days, it's pretty hard to see why you would choose it over other offerings.

In a vacuum we have no major concerns. The unit is more than powerful enough to plough through general workloads and while the GPU is only capable of light gaming or graphically intense workloads, it's enough for most people.

The screen hinge is fractionally more free than we're comfortable with, since you can move it without using your hand, so if there's any loosening through wear then this could become a concerning trait. The keyboard is also a little shallow and the trackpad is left-of-centre. Minor gripes, but they're the kinds of things you really don't expect on the most coveted level of Ultrabook.

A decent lightweight Ultrabook that isn't far behind market leaders.

Joel Burgess

★★★★☆

GAMING LAPTOP

Lenovo Legion 5i Pro 16”

Lenovo’s got a new performance gaming laptop range and it’s not light on high end components.

■ $4,599 | lenovo.com/au

■ W11 Home; 16-inch IPS display at 2560 by 1600 pixel resolution, VESA HDR400, 165Hz, 100% sRGB X-Rite Pantone calibration; Intel Core i7-12700H CPU; Nvidia GeForce RTX 3070 Ti GPU; 32GB RAM; 1TB PCIe SSD; 80Wh battery (2h11min 1080p movie playback); 35.9 x 26.4 x 2cm; 2.49kg.

The pitch for Lenovo’s Legion 5i Pro 16” is “Stylish outside. Savage inside.” and while the first part of that equation might be a bit of a stretch, the spec sheet definitely backs up the potential for serious gaming. There are a handful of configurations locally, but they all take a slightly thicker performance-first shape that is just a tad bigger than your average gaming ultraportable. That by no means makes it hard to transport, since this 16-inch device weighs just 2.5kg, but there is a distinct wedge in the tail end of the 2cm thick unit to accommodate all the vents and thermal architecture. Lenovo has done a decent job of tying this all into a relatively neat package that could just as easily pass as a work laptop as a speedy gaming rig, but just don’t expect it to have the same profile as a Dell XPS.

The Legion 5i Pro 16” comes in a range of configurations, starting with devices priced at $3,049 offering solid 1080p gaming performance with a Nvidia GeForce RTX 3050Ti GPU, through to units costing $4,599 with an RTX 3070 Ti. Lenovo sent us the latter, and that GPU has a TDP of 150W which puts it at the top end of GPUs we’ve tested. Combine that with 32GB of RAM and an Intel Core i7-12700H CPU and you have a unit that’s poised to offer impressive gaming performance.

If we pit it against a MSI GE76 Raider with a 155W 3080 GPU from 2021 you get almost identical gaming performance, which is why you don’t see many GPUs higher than the 3070 Ti in 2022. This means it’ll get 100 fps plus on most titles using 1080p Ultra or above about 50 fps for QHD on demanding modern titles. Almost all of the configurations use an Intel Core i7-12700H CPU, which is more often than not the equal best processor you can get, so there’s no shortage of power in general computing and work tasks either.

These solid components collaborate with a pretty high spec 16-inch display to deliver a high-resolution high-refresh-rate gaming experience. Sure the 2560 by 1600 pixel resolution isn’t the maximum you can find, and neither is the 165Hz refresh rate, but both of these represent a good balance of premium gaming performance and price when you consider exactly how the system performs.

While there is an 80Wh battery on board, the powerful components will drain it in around two hours, depending on the task, even with Nvidia’s Optimus GPU switching tech. The system also has an AI powered automatic game detection setting that you should definitely turn on if you want to avoid losing 10-15 percent performance out of the box. You’ll have to manually dig into the Lenovo Vantage system tuning software to check the box on balanced power mode, but once you’ve done this the performance takes care of itself.

The speakers, webcam, keyboard and trackpad are all perfectly adequate, so there’s no major limitations here either. At full RRP, none of the Lenovo Legion 5i Pro units are exactly the best value around since you can get similarly specced units with half the RAM and better screens for between $500 to $900 less, and over $1,300 less when on sale, so there’s a lot of wiggle room in there to find a better deal. We have seen these devices on a 30 percent discount on Lenovo’s online store, at which price they become quite competitive.

	Lenovo Legion 5i Pro 16”	MSI GE76 Raider (2021)
PCMark 10 - Overall (score)	6,754	6,974
Max CPU Temperature (C)	97	100
1080p movie playback (HH:MM)	02:11	05:21
Cinebench R23 - CPU (Score)	14,185	11,922
3DMark Time Spy (score)	10,978	11,188
F1 2021 - 1080p Ultra (fps Av.)	132	131
CrystalDiskMark Read (MB/s)	7,058	6,698
CrystalDiskMark Write (MB/s)	5,285	5,032

A solid performance-first gaming laptop that is a great buy if on sale.

Joel Burgess

★★★★☆

GAMING MONITOR

Dell 32 4K UHD Gaming Monitor G3223Q

Dell's giant gaming monitor has some awesome specs, but is it the best expression of the ideal living room PC display?

■ $1,499 | www.dell.com

■ 32-inch IPS display at 3840 x 2160 pixel resolution; 138ppi; DCI-P3 95%, sRGB 99%, Vesa HDR600; 400nit typ. brightness; AMD FreeSync Premium Pro, G-sync compatible (unofficial); 2 x HDMI 2.1 (supports 4K 144Hz @10bit 4:4:4 with DSC), 1 x DP 1.4, 3 x USB 3.2, 1 x headphone jack; 72.6 x 42.7 x 6.9cm; 6.03kg.

Since the tail end of 2021 there has been no shortage of monitor manufacturers releasing their own take on the 4K 144Hz large-format monitor, so Dell's 32-inch 4K 144Hz gaming monitor has quite a bit of competition. With an RRP of $1,499 it's not cheap, but it lines up pretty nicely with the competition based on the particular feature set it offers. You can get bigger displays at similar prices if you sacrifice a bit on the refresh rate and you can get cheaper units, but they're usually a little dull.

Looking at the spec sheet you can see that this screen is premium in all the places it can be. In addition to being a proper 4K panel with a 144Hz refresh rate, this device offers a solid HDR colour, meeting 95 percent of the DCI-P3 gamut. And while this isn't quite good enough for professional HDR colour grading – as some similarly priced competitors are – it does have a delta E of under two so it's close enough to be functional for that in a pinch or for SDR colour spaces.

For things like gaming and media the colours are more than satisfactory making HDR and SDR content look vibrant and detailed. There's even a peak brightness of 600 nits that means this unit gets Vesa HDR600 certification, which is bright for a monitor. Obviously that is still some way off the 1000 nit minimum that a TV needs to be to get a HDR classification so you won't quite get the same experience if this is for a living room PC, but not many monitors offer TV-level brightness yet.

> "This 32-inch display is a generous size for a desktop."

HDMI 2.1 means you can run 4K 120Hz from your console without any colour compression or full 4K 144Hz over the Display Port 1.4, but there's no Thunderbolt/ USB-C display capabilities for those that may need them.

If you like a flat screen this 32-inch display is a generous size for a desktop, and it's bordered by a modern minimalist bezel so it'll look good even if you don't have anything running on it.

There is one thing to point out, it's only advertised as an AMD FreeSync Pro, which means it can run your games at fast refresh rates and high resolutions, even when you're using 10-bit HDR colour. It doesn't however offer any G-sync certifications, so while you'll still get standard compatibility you won't be able to run screen tear-free, using HDR, at high frame rates if you're connecting it to a Nvidia GPU.

The stand is solid and capable of supporting the various tilt, raise and rotate motions the screen offers. It's got a blue LED lighting strip on the back panel to sync with your other Dell/ Alienware kit, if that's your thing.

There's also no speakers, so you'll need some headphones or a Bluetooth soundbar if you want to also be able to hear whatever is on your PC or console.

A great 4K monitor that works as a HDR TV for console gaming with a few small omissions.

Joel Burgess

★★★★☆

MONITOR

Prism+ PG270 Ultra

There's a new 4K high refresh rate gaming option to consider.

■ $999 | www.prismplus.com.au

■ Prism+ PG270 Ultra LCD Monitor; 27-inch; 3840x2160 resolution; 144Hz refresh rate; HDR400; 1ms (GTG) response time; In-Plane Switching (IPS) panel; FreeSync compatible; 1x DP 1.4, 2x HDMI 2.1; Three-year warranty.

Prism+ is making a big push into the Australian market. Prism may not be a household name just yet, but many of its products come with an excellent spec and offer good value for money. With those two things to build upon, there's little reason you shouldn't give Prism a look when considering your next monitor purchase.

Following on from the C315 Max in our last issue, which we praised, Prism sent over a PG270 Ultra. It's a 27-inch flat IPS monitor with a 4K resolution. It's a gaming-oriented model with a 144Hz refresh rate and a 1ms GTG response time. Add to that FreeSync support and you've got the ingredients for a high quality and very capable gaming screen.

Assembly is about as easy as it gets. You attach the rear of the stand to the base with a single thick screw and then attach it to the rear of the monitor itself. Done. It's very sturdy and offers tilt, swivel and height adjustment with a hole for cable management. It's difficult to find any fault at all here. There's support for 75x75 VESA mounting.

The PG270 Plus's connectivity options are excellent. You get dual HDMI 2.1, DP 1.4 and USB 3.1 type-C with 65W charging capability. There's a 3.5mm line-out but note there are no speakers.

As you'd expect on a panel with very high pixel density, the image is very sharp, though unless you sit very close to the screen, or have very good eyes, you'll likely have to set your OS scaling to 150 percent.

The IPS panel delivers a high-quality image, with well contrasted colours and minimal backlight bleeding. The brightness is high out of the box, but dropping it a bit lower is trivial. There's limited HDR support (HDR400) though full HDR is something that's generally limited to flagship monitors costing a bit more.

Firing up *Tiny Tina's Wonderlands* for a bit of a frag fest showed off the PG270 Ultra at its best. The game features a stunning colour array and the cell shaded graphics really pop out. With its 144Hz refresh rate and 1ms response time, the screen was a clear step up from my 34-in Ultrawide VA screen in terns of responsiveness and colour reproduction.

The PG270 Ultra is first and foremost, a gaming screen. It's overkill for a productivity or general use monitor where its 27-in size counts against it, though with a claimed 130 percent sRGB coverage and the IPS panel, it delivers better colour accuracy than most TN or VA screens.

So, as a gaming option, the Prism PG270 Ultra is very impressive. But then the competition is tough in this price range. The PG270 Ultra was selling for $999 at Prism's site at the time of writing. That's more expensive than similarly spec'd MSI and Gigabyte competitors. However, Prism often run sales, so there's every possibility that you'll be able to find it cheaper in the months leading up to Christmas.

If you can get one for a discount, you'll be rewarded with a fast, clear and colour accurate screen with an excellent stand and a three-year warranty. Prism is a brand that you should keep an eye out for.

The Prism+ PG 270 Ultra is a very competent gaming option, though it faces tough competition in its price range.

Chris Szewczyk

★★★★☆

WI-FI 6E ROUTER

TP-Link Deco XE75 AXE5400 Tri-Band Mesh Wi-Fi 6E System

Modern Wi-Fi mesh systems all offer disappointing performance. Can this Wi-Fi 6E system break the mould?

■ $999 | www.tp-link.com/au

■ Speed: Wi-Fi 6E 5,400Mbps | Connectivity: 3 x 3 x Gigabit LAN/WAN | Features: Family controls, Alexa support.

The idea of mesh Wi-Fi systems is that they, not only spread Wi-Fi around your premises by adding nodes that enhance a core signal, they maintain performance levels too. But, after testing every key model on the market, we can vouchsafe that they don't – performance inevitably collapses near a secondary node and the best we can say is that, at least mesh systems enable constant (if reduced) performance at range. The move to Wi-Fi 6 didn't help but now here's Wi-Fi 6E... will mesh finally live up to its promise?

The first thing to note is that the tri-band Deco XE75 uses a 2.4GHz channel (574Mbps theoretical maximum), a 5GHz channel (2,402Mbps) and the extended (much-less-crowded) 6E spectrum which operates between 5.925GHz to 7.125GHz but still supports a Wi-Fi 6-like, theoretical-maximum 2,402Mbps. In the Deco's case, it reserves this '6GHz' spectrum for backhaul between nodes. We had high hopes because the best Wi-Fi performance we've seen comes from twin-node 'mega mesh' routers that do likewise (albeit over regular, Wi-Fi 6 spectrum). It also means that our usual, Dell XPS Wi-Fi 6 laptop shouldn't experience performance loss.

We ran our standard download tests in our Sydney weatherboard cottage: next to the primary mode in the middle of the residence; the front-room (two rooms away, next to second node); and 25m at the end of the garden, with the third node in the back room (a room away from the primary node). While it achieved, a respectable 602Mbps up close, it scored 596Mbps in the front room – just a one per cent drop-off! In the garden it managed 254Mbps – that's five-times faster than any rival!

We ran the tests on newer laptops with integrated Wi-Fi 6E but the Dynabook Portégé X40L-K's up-close score was halved due to the newer-but-weaker CPU. We switched to the beefier Asus Zenbook 14X which scored 676.6, 520 and 119.5Mbps respectively. This makes us suspect that close-up Wi-Fi 6E performance is affected by CPU grunt but a superior antennae array (like in our old Dell XPS) still makes a difference at range. The Deco's app displays an option to use Wi-Fi 6E for standard connectivity as well as backhaul, but it wouldn't work. Ultimately, regardless of laptop, the XE75 offers the best performance at range we've ever seen.

The app makes set-up simple and adds to the usual features with smart-home automation features and parental controls. However, we're annoyed about paying extra for basic features like 'device time limits' and 'off-time' which come with the premium, $9-per-month, HomeShield Pro (security) add-on. The latter is worth considering if you utilise smart-devices, though, as each dumb-device needs network-based 'Edge' security, lest it be used to compromise your network.

Our main gripe is the price – at $999 it's incredibly expensive but it's also the sort of premium we expect when it comes to new technology. There are faster gaming routers plus cheaper, better-featured and more-complex alternatives (like Synology's $520 RT6600ax router) but none offer the plug-and-play simplicity, speed and range afforded by the Deco XE75.

Offers the simplicity, speed and range most people want from a mesh system. But it's expensive.

Nick Ross

★★★★★

"The app makes set-up simple and adds to the usual features with smart-home automation features and parental controls."

apc EDITOR'S CHOICE

WI-FI 6 MESH

Mercusys AX1800 Whole Home Mesh Wi-Fi System

Can this budget brand set the world alight with a cheap Wi-Fi 6 mesh kit?

■ $350 | www.dlink.com.au

■ Speed: AX 1,800Mbps | Three nodes | Connectivity: 3 x Gigabit LAN | Features: Parental controls, QoS.

Last year, TP-Link realised that its Wi-Fi products were among the best on the market. It subsequently evolved into a premium purveyor of Wi-Fi and launched a new junior brand: Mercusys. The brand's first Wi-Fi router offered such impressive performance at a budget that we cited its existence as proof that the Wi-Fi 6 market was finally mature. However, usability was hampered by having no phone app and all set-up requiring an old-school web browser. Now we have a three-node Mercusys Wi-Fi 6 mesh kit and there is a phone app. Would it impress?

The quick-set-up guide told us to download the Mercusys app and follow the instructions. This involved turning a single node on, waiting a minute for the LED to stop flashing, seeing the app identify it, setting a network name and password and connecting to it. Too easy. Then it came to adding the other nodes and we were told to place them, turn them on and wait two minutes. Despite there being no notification, everything worked swimmingly.

The high-quality, brick-shaped nodes look good and each has three Gigabit Ethernet ports which can be useful in smart homes in the era of hybrid work – when you might what to connect NAS boxes, smart TVs, PCs and set-top boxes to a more-robust connection. However, we're yet to test a great mesh system: the promise of peak performance at distance still hasn't materialised even with the move to Wi-Fi 6 (not including super-premium systems with dedicated backhaul channels). So, how did the Halo H70X perform?

We tested it in our Sydney weatherboard bungalow by downloading large video files from a primary node cabled to our NAS, via our Wi-Fi 6 laptop. We did this up close to the node (in the middle of the house); by a second node, two rooms away (at the front of the house) and then 25m down the garden (with the third node in the back room). Up close it managed a very impressive 618Mbps which is only a little behind the fastest score we've seen from a mesh. Two rooms away it managed 121.7Mbps which represents the typical, disappointing, performance drop-off we seem from most mesh systems. It's not slow, though, and casual users won't care. However, at the end of the garden it managed an excellent 77.7Mbps (some rivals struggle to connect). Ultimately, it should provide great range and decent performance for all but the largest mega-mansion.

The phone app is slick and offers useful features including guest network, port forwarding, device-based QoS and some impressive parental controls. The latter include timed use, content filtering and bedtimes for different people with different devices. There's aren't any additional browser-based features.

Ultimately, the Halo H70X offers everything a casual user needs to dramatically improve the range of their network at speeds that only professionals might lament. At $350 for three nodes it's also considerably cheaper than similarly performing rivals. If you just want to boost your home's Wi-Fi this is most people will need.

If your requirements are to boost your Wi-Fi so it works well everywhere, then this is all you need.

Nick Ross

★★★★★

WI-FI 6 ROUTER

Asus ZenWiFi Pro XT12

Asus' latest mega-mesh, pro-spec router system is turning heads. But, is it worth paying for?

■ $1,499 | www.asus.com/au

■ Speed: Wi-Fi 6 11,000Mbps | Connectivity: 2 x 2.5Gbe WAN, 2.5GbE LAN, 2 x Gigabit LAN | Features: Parental controls, IPS security, VPN tunnelling, Google Assistant & Alexa support.

There are full PC systems that are smaller than Asus's ZenWiFi Pro XT12 nodes. These, erm, twin towers, are packed with powerful components and a channelled-air cooling system that's partnered with beefy heatsinks. The idea is to create a powerful Wi-Fi 6 mesh (with a dedicated backhaul channel between nodes) that's as robust as it is packed with features to the point where it can support Wi-Fi networks of SMBs. It comes with a hefty price tag, so is it worth buying?

First: performance. It utilises a 2.4GHz band and two 5GHz bands for a theoretical maximum throughput of 11,000Mbps. You can set which band (or Ethernet connection) acts as a dedicated backhaul link between the nodes or leave it (as we did) set on Auto. Past experience tells us that dedicated backhaul links make mesh much faster.

In our Sydney weatherboard cottage, we set the first node up in the middle room by the modem and the secondary node two rooms away at the front. We tested next to both nodes and 25m down the back garden. Up close it scored, 627Mbps which is fast, but still 100Mbps slower than other, top Wi-Fi 6 rivals. Next to the secondary node, it scored 609Mbps – just a three per cent drop-off and the fastest speed we've seen! Outside, at the bottom of the garden, however, this dropped to 46.6Mbps which is respectable for a standalone router but beaten by mesh kits with a third node.

It's worth noting that the 2GHz quad-core processor, eight antennae and internal smarts should be able to handle multiple, demanding, concurrent, device connections, much more easily than equivalent consumer routers.

Other notable performance-related features include each node having a 2.5GbE WAN port, a 2.5GbE LAN port and two 1GbE LAN ports which can be aggregated for 2GbE. This will please people wanting to connect NAS boxes and the like.

Both towers look impressive with their unique design and glowing graphics. Set-up is simple via the app which is intuitive and offers excellent monitoring and management tools including powerful QoS options and a useful 'Insight' tab that offers advice regarding configuration. You can access everything remotely and use a separate 'Instant Guard' app to filter traffic via your router when browsing using public hotspots.

Power users and sysadmins will warm to the extensive features accessed via a desktop browser which are also fast to access.

Meanwhile, Asus' AiProtection (powered by Trend Micro) offers IPS (Intrusion Prevention System) security and the usual parental controls. However, taking advantage of the best levels of protection requires a Trend Micro subscription which is $90 per year.

It's ultimately a very good, powerful mesh system but at $1,499 it's incredibly expensive. Even with Synology's RT6600ax router creeping up in price to $520, buying two of those (and connecting them together) would still save you $460 and provide you with a better-performing, better-featured equivalent for SMBs and prosumers. Unfortunately, although the Asus ZenWiFi Pro XT12 looks more attractive than the Synology, that's not enough to justify the price.

Big, powerful and packed with features. But very, very expensive.

Nick Ross

★★★★☆

USB MICROPHONE

Audio-Technica AT2020USB-X

A new and improved version of the classic AT2020USB+ but at a high price.

■ $269 | www.audio-technica.com/en-au

apc EDITOR'S CHOICE

The increased demand for new USB microphones over the last few years of the pandemic has seen a plethora of new models released, with many an aspiring content creator looking for the right hardware to suit their needs. And while the core of the pandemic seems to have now passed, that demand has not gone away.

Audio-Technica's new addition to meet that demand is a reimagining rather than a re-invention of the wheel, taking the well-loved AC2020USB+ and updating it for the needs of today's streamers and creators. Starting at the bottom of the capsule you'll find the main USB-C port, the associated cable is USB-C to USB-A however a handy A to C adaptor is provided for those that need it.

"From the outside to the inside the AT2020USB-X features a cardioid condenser and offers a maximum 24-bit depth at a 96kHz sampling rate with a 20Hz to 20kHz frequency response."

Speaking of adaptors, you'll also find a handy 3/8in to 5/8in adaptor for those wanting to not use the included stand – which while fantastically built and functional – is somewhat short.

Coming up to the front of the capsule you'll find a large touch sensitive mute button that also switches the USB-X's blue backlighting to red to indicate its status. Directly above the mute button you'll find a mix control allowing you to dial between latency free monitoring of the microphone and playback from the computer, while on the right is a volume control. Both of these govern what you'll hear from the 3.5mm headphone jack on the back of the capsule.

The overall build quality is fantastic with a simple and elegant look in a black finish, function is clearly the goal with the USB-X but form has not been forgotten.

From the outside to the inside the AT2020USB-X features a cardioid condenser and offers a maximum 24-bit depth at a 96kHz sampling rate with a 20Hz to 20kHz frequency response.

The sound quality is overall fantastic with a great natural sound, though you'll find yourself wanting a pop filter to protect from those plosives. The noise rejection works well in most circumstances but it does suffer in more open spaces prone to echoes, in smaller areas with a little noise deadening it's perfect, though you can expect to pick up a little mechanical keyboard noise if you have the keyboard set up too close to the front or the side of the mic.

Setup for the USB-X couldn't be easier, simply plug and play and you're good to go. The only adjustments you may need to do will be the gain settings which are taken care of in your PC sound settings, this is actually one of the few things I feel the USB-X is really missing, it could have used a gain dial on the capsule itself along side the mix and volume dials.

Overall, the AT2020USB-X is a fantastic microphone without question, but then there is the elephant in the room, the cost. As we said in the beginning the market is currently spoiled for choice when it comes to USB condenser microphones, the USB-X coming in with a recommended retail price of $269 puts it at the top of the price range. While you will be hard pressed to find a mic that has both this build quality and this audio quality combined, you can get very close for a much lower cost if you're willing to sacrifice in some areas.

■ USB2.0 compliant; Element: Fixed-charge back plate, permanently polarised condenser; Polar pattern: Cardioid; Frequency response: 20-20,000 Hz; Bit depth: 16 bit/24 bit; Supported sampling rates: 44.1 kHz/48 kHz/88.2 kHz/96; Dimensions: 142 mm long, 52 mm maximum body diameter; Weight: 373 g; Headphone output: 110 mW.

A fantastic microphone that does almost everything right, but at a premium price

Nick Read

★★★★★

GAMING HEADSET

ALIENWARE TRI-MODE AW920H

Funny looking things, with fine-sounding sonics.

■ $379 | dell.com

What a pleasant surprise these turned out to be. These odd looking cans exceeded our expectations on almost every front. The sound is warm and very well balanced. Movies, games and music all work well with this soundscape, without one type compromising the other. The sound isn't exceptional in any particular area, it's just solid quality and in our experience was a natural rendition of the source.

They're certainty not cheap, but being Dell, these will almost certainly be offered at an appealing discount at some point. I'd rate the audio as being very close to the Sony WH1000XM3 – being the more neutral Sony before they went bass-heavy for the XM4.

Dolby Atmos is fully supported, which is rare and explains part of the price premium. If your game or movie supports Atmos these deliver a rich surround experience.

The Bluetooth signal strength is just about the best I've tried, with them holding up flawlessly in the far corner of my home that every other set fails in. The wireless dongle for gaming is USB-C. Thank you, Alienware. Some Reddit users reported some lag via wireless during gaming, but in our experience it was just fine.

> "I'd rate the audio as being very close to the Sony WH1000XM3"

There are a couple of downsides. The mic is weak. My mates in games would often ask me to speak up. If you're a bit of a talker in games these should not be your first choice. They're also a bit hot and heavy on the ears, with a very strong clamping force too. The ANC is below average, too, and is barely up to the task for planes and trains. But as general purpose cans they're quite impressive.

Alienware has delivered a set of cans that can serve as go-to all rounders for any use.

Ben Mansill

★★★★☆

GAMING HEADSET

JBL QUANTUM 810 WIRELESS HEADSET

Premium gaming sound with ANC packed in.

■ $349.95 | www.jbl.com.au

A couple of issues ago (*APC* 509) JBL impressed with the fantastic Quantum 610, and here we are again, a little further in the future, donning the 810s and feeling similarly, if not more impressed.

Out of the box there's a definite premium feel to the Quantum 810. The build materials are a little shinier and slicker looking overall when compared to lower tier Quantums. There's loads of padding where it needs to be and even with a little more heft at 410g, there was no issues wearing the headset for long sessions. The controls are intuitive and easily accessible on the backside of each can including discreet game / voice chat controls for the fold-away boom mic.

The unit is primed for just about any connection option you'll ever need, there's 2.4GHz wireless for the PC and the latest-gen consoles, Bluetooth 5.2 compatibility as well as a 3.5mm jack for everything else. The Bluetooth signal is rock solid, easily acing the bio-break test, and then the backyard and back shed test before getting shaky. With JBL Quantum Surround (PC only) and DTS Headphone:X version 2.0 support, the 50mm drivers proved more than capable.

The sound is clear, crisp and detailed across the board, with no real bias toward one end which can often be the case with bassy gaming cans. PC users can dig in and tailor their sound and RGB effects even further with the intuitive QuantumEngine app.

While not traditionally a feature we'd look for in gaming cans, the 810 boasts Active Noise Cancelling. It's capable enough to knock out device buzz but definitely doesn't hit the same marks as the major players in the ANC space. We get the feeling JBL is appealing to travellers here, but keep in mind the mic is not detachable and you'll be lit up like an RGB Christmas tree on your commute. A solid all-rounder headset but more focused gaming options are around for cheaper.

Solid performance with the welcome addition of Bluetooth. Look elsewhere if ANC is a top priority.

Troy Coleman

★★★★☆

WIRELESS BUDS

GOOGLE BUDS PRO

The perfect buds for Android phones.

■ $299 | store.google.com

Google has entered the 'Pro' earbuds arena and it's done so with a properly top tier audio product that also does better than most with its smartphone integration.

The sound is clear and nicely balanced. The bias is obviously towards mids and highs, and voices – whether in music or a call – are crisp and clear. Bass isn't full phat, but packs enough heft to satisfy. It's a rich and deep sound overall, but with a pleasing clarity that shows no fear or favour towards any particular music genre.

"The sound is clear and nicely balanced."

Once connected, your Android phone can perform a short 20 second test to verify the effectiveness of the seal in your ear canal. It's a good way to pick the right bud size out of the box and not worry about that again.

Touch controls are extremely good, and apart from learning the ropes initially, after the first few minutes they didn't once fail to do as I instructed. Unsurprising, they integrate seamlessly with Android. Various options for notifications are here, and for busy types that want these in for long periods you can operate your phone's Assistant extremely effectively. Other buds can do this, but being a Google product it all just works without any grief and gets more impressive as you use it.

Two devices can be simultaneously paired, which makes it handy to stay linked to your phone while enjoying music via a computer, or whatever configuration you like. Audio will switch between devices as needed, as long as both are using the same Google account.

Top-tier utility and design beyond just music, but damn good at music too.
Ben Mansill

★★★★☆

WIRELESS BUDS

HUAWEI FREEBUDS PRO

Do these shine on the inside as well as the outside?

■ $349 | consumer.huawei.com

Technically, these tick a few boxes. They feature dual-speakers – being a standard 11mm driver for bass and mids, and a planar diaphragm for highs. There's an adaptive EQ that adjusts the sound based on ear pressure, and like the Google Buds Pro there's also a seal test.

A game mode with "up to" 90ms latency is here, and they support Huawei's HWA lossless audio standard, which is capable of extreme sampling rates over Bluetooth.

"To cut to the chase, they just don't sound good"

They also look a treat with a shiny metallised finish (black and white also available), and they're certainly comfortable and stay in place well.

But to cut to the chase, they just don't sound good, at least at this price tier. The audio was "co-developed" by Huawei and French audio specialist Devialet. So, along with the dual-driver design – they should sound fantastic. Alas most music sounds unnatural and very much over equalised. It's a thin and tinny sound, with bass that rarely if ever punches. The music I listened to over several days mostly didn't sound true to the source material. It's as if it had been filtered, filtered again and then had the mid range reduced severely so the treble can shine. But the treble doesn't shine, it's weak and lacking emotional musical feel.

The four EQ presets (Default, Bass boost, Treble boost, Clear Vocals) just shift the failings around to different ways of disappointing you. Voice is fine for calls and the ANC is above average. The app, which must be installed from Huawei as the Play Store still doesn't allow it (not Huawei's fault), is decent.

At around $200 these would be acceptable, but at full RRP Huawei is asking too much and delivering too little.

Over-processed audio that strips the heart and soul from most music.
Ben Mansill

★★☆☆☆

MOUSE

Logitech MX Master 3S

The best productivity mouse.

■ $169 | logitech.com

Logitech's MX Master mice have carved a niche for themselves as the navigation product of choice for people who want good quality, lots of features, and loads of customisation options. The MX Master 3S aims to continue this tradition by building on the success of the MX Master 3 with a brand new higher DPI sensor, quieter switches, and Logitech's new Bolt dongle which can be used across a range of the company's new wireless products.

By building on such a solid foundation, this remains the best productivity mouse on the market. This is an extremely comfortable mouse to have in the hand for long periods, it feels built to last, and Logitech's Flow software allows you to move seamlessly between devices and applications. This makes it highly efficient for video editors, programmers, or office workers looking to get stuff done.

It's just so well made, with a luxuriously rubberised finish that's comfortable to hold for long periods, and a sturdy, made-to-last construction. It's not a small mouse so is best suited for someone with medium-to-large hands. Bear in mind that the scoop designed to rest your thumb means this mouse will also only suit right-handed people.

Controversially, the biggest change to this model of mouse is that the main click buttons have been switched from 'clicky' types to quieter models that Logitech claims are 90 percent quieter. This is great for office workers who respect their co-workers' sanity, but less so for home workers who might have preferred the more tactile feel.

> "The MVP of the MX Master 3S, though, is the Logi Options+ app"

The other buttons and wheels on the mouse all feel fantastic, as they did on the previous model. The electromagnetic scroll wheel can be set to freewheel or go tactile, plus there's a thumbwheel for zooming, horizontal scrolling, or a host of other customisation options. The big change in this model is the sensor, which can go from 200dpi up to 8,000dpi – double the 4,000dpi limit of its predecessor. This means the mouse is better suited to people with multiple-monitor setups, as you can navigate around with less movement. The sensor also gets bonus points for working across any surface, including glass.

The MVP of the MX Master 3S, though, is the Logi Options+ app. If you're working across multiple computers, then it allows you to flow between them with ease. For example, I spend most of my time on a desktop PC, but I always have my work laptop next to me as well. I had the mouse connected to my desktop using the Bolt receiver and also paired to the laptop over Bluetooth, and was able to move between the two with ease, including copying and pasting text.

Battery life is excellent, rated at 70 days, meaning you only have to remember to charge once every three months or so. The good news is that you can charge while using it, or you can just give it one minute of juice, which will be good for a few hours of use.

Working from home over the past couple of years got us all thinking more about ergonomics, comfort, and even a little luxury in our working setup. If that's you, then the Logitech MX Master 3S Wireless mouse fits the bill.

Smooth and ratcheted scroll wheel, excellent software and great build quality.

Guy Cocker

★★★★☆

Windows 7, 8.1, 10 or 11 | www.mitec.cz/tmx.html

MITEC TASK MANAGER DELUXE

See what's going on under the hood.

One of Microsoft's strangest decisions in Windows 11 was to remove the option to launch Task Manager from the taskbar, effectively hiding this useful tool. MiTeC Task Manager DeLuxe (MTMD) version 4.4 is an enhanced version of the feature, giving you a clearer and more detailed view of what's happening in the background on your PC. This helps you to monitor resource hogs, and prevent system crashes.

We'd been planning to include the program in this section since version 4.1 was released in May, but the download kept triggering a security warning in our browser. Thankfully, this problem has now been fixed and MTMD is verified as completely clean on VirusTotal. Despite the 'Deluxe' in its name, all its options are free to use for personal, non-commercial purposes.

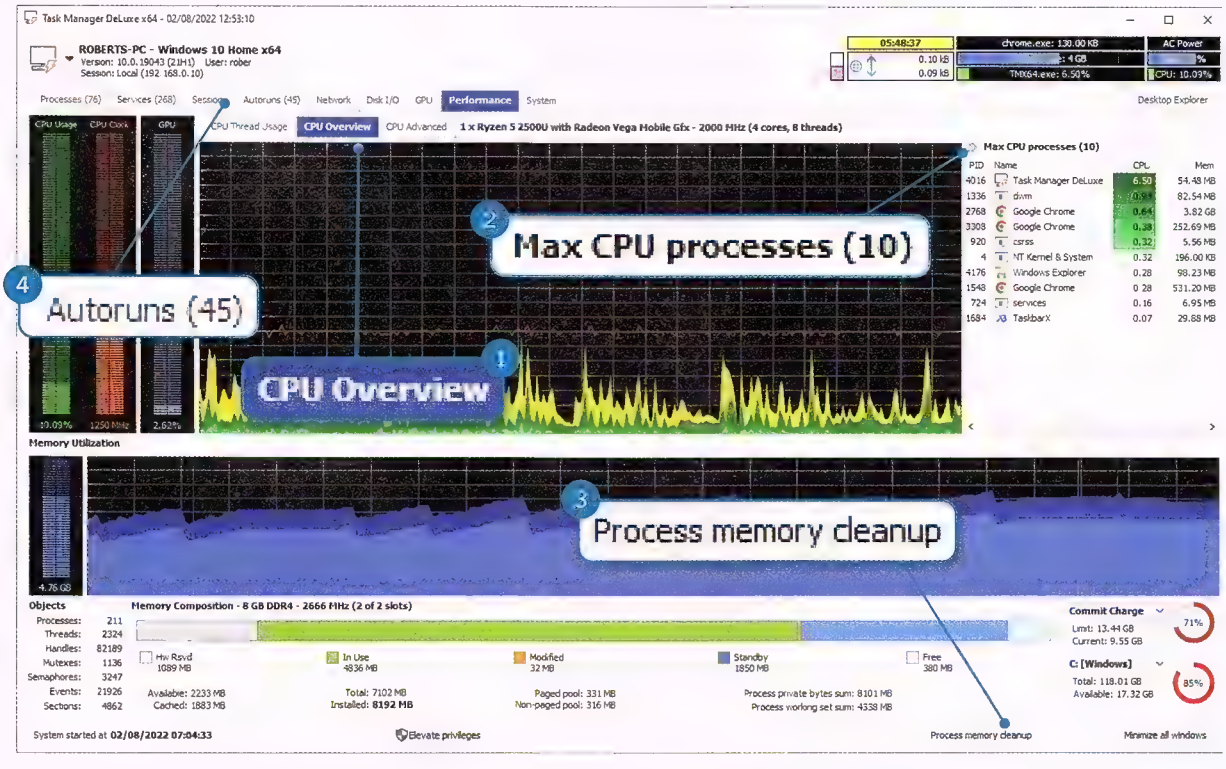
Version 4.4 lets you quickly check whether Secure Boot is enabled on your PC – a requirement for installing Windows 11 – by clicking the System tab and scrolling down to the Security section. This tab also tells you the make and model of your processor, graphics card, network adapter and lots of other useful information.

Another handy addition displays details in the top-right corner of which process is currently using the most memory – unsurprisingly, this was Chrome on our computer. MTMD also now shows a more accurate reading of your hard drive or SSD's temperature.

The program's interface is packed with options that can seem intimidating at first, but the most important tabs to focus on are Processes (which monitors everything running in the background), Autoruns (which serves as a startup manager) and Performance (which displays graphs of your current CPU and memory usage).

> "Despite the 'Deluxe' in its name, all its options are free to use for personal, non-commercial purposes."

MTMD does not require installation so you can run it from a USB stick, whenever you need instant information about your system.


Task Manager DeLuxe x64 - 02/08/2022 12:53:10
ROBERTS-PC - Windows 10 Home x64
Performance
CPU Overview
Max CPU processes (10)
Autoruns (45)
CPU Overview
Process memory cleanup
Memory Utilization
Memory Composition - 8 GB DDR4 - 2666 MHz (2 of 2 slots)

1 Click the Performance tab then CPU Overview to see graphs of your PC's current processor and memory usage. Watch out for unusual spikes in activity, which may indicate a rogue background process.

2 The Max CPU Processes box tells you the 10 programs and processes that are using the most processing power and memory. For more information about all active processes, click the Processes tab in the top-left corner.

3 You can free up system memory by clicking the 'Process memory cleanup' button at the bottom of the window. This will temporarily release RAM from unnecessary background processes.

4 Click the Autoruns tab to view details of all the programs and processes that start automatically with Windows. To disable these, you need to click 'Elevate privileges' to unlock administrator rights.

iOS 14.5 or later | Free (Premium $22.99, Premium Lifetime $79.99) | user.camp

PENBOOK

Digital note-taking with a creative human touch.

Pick a paper type and annotate it freely using your finger or an Apple Pencil.

Pairing an iPad with an Apple Pencil is something that's often been thought of in terms of enabling artists to create art, which of course they do. Another, somewhat overlooked application is for creating a digital version of a notebook or sketchbook, for jotting down notes or sketching ideas. This is possible in iPadOS' Notes app of course, but only in a fairly basic form. Penbook takes this idea several steps further, aiming to combine the tactile feel of a real notebook with the smarts of modern tech. Although you can draw in this app using touch, an Apple Pencil is highly recommended to get the most out of what it offers.

You begin with a notebook, either your own blank one or one of the presets, and you can add your own pages and mix and match from any of the stationery types using the menu. There are over 300 types in scientific, planning and academic styles and although you could have a whole book of one type, you can add in a new type of page at any point. As well as all manner of lined papers there's dotted paper, graph, ruled, musical tablature and score paper, planners, storyboards and more. Stationery containing dates such as a weekly planner for example knows the current date and will display dates accurately meaning you don't have to set this up. Page types can be customised and there's Calendar integration too.

> "It's extremely intuitive and fun, very accurate and responsive to Apple Pencil and super flexible in terms of how it lets you mix and match paper types."

You can draw freely in any page using a selection of pen tools, with each one having configurable colour, tip and weight settings and there is, of course, an eraser tool. Images can be imported easily, and content copied and pasted from the clipboard. A scratch pad is available for thumbnails and there's also text notes which support keyboard input as well as handwriting-to-text, and these can be used as stickies on any page. It's possible to search handwritten notes for words, customise book covers, and shape recognition and snapping is available for more accurate drawing.

The best way to think of Penbook is as a real notebook. It's extremely intuitive and fun, very accurate and responsive to Apple Pencil and super flexible in terms of how it lets you mix and match paper types. The free version is almost entirely unrestricted – only one notebook at a time is allowed, but all features are available. The paid version allows unlimited notebooks. These can be exported as images or PDFs.

It's fair to say that making nice-looking notebook content requires the same skills as it would with a pen and paper, so a modicum of artistic flair will help. Even if your penmanship is more basic, however, you'll still find Penbook the best way to create and manage notes and sketches on your iPad.

A novel and creative notebook solution for iPad.

Hollin Jones

Various licences available | https://amos-xfce-iso.sourceforge.io

AMOS 22.08.02

Mayank Sharma always falls for beautiful-looking Arch distros, but he wonders if this one does enough to appeal to others...

AmOs is a new distro that's based on ArcoLinux, which itself has only been around for just over five years. ArcoLinux is pitched as a platform to learn Linux the Arch way. Its developer has broken up the Linux learning process into six phases and the various ArcoLinux distros are part of those phrases. The final phase of the learning process calls for the creation of your own custom distro.

AmOs is one such derivative. Its sole developer has done a nice job of utilising the tools at his disposal to create a desktop-friendly Arch distro. AmOs uses a heavily customised Xfce desktop. One of its major attractions are the dozens of themes that you select with a single click.

The distro boots into a Live environment, before firing up the Calamares installer. You can exit the installer to explore the distro before you anchoring it to your hard disk. Handing off installation to the Calamares installer is a smart decision since it gives people who lack the skills to install Arch an option to experience the benefits of Arch without sweating as much.

The customised Xfce desktop features a Plank panel at the bottom with links for various programs. The panel at the top has been customised as well with various applets to display system information. There are several applets on the desktop as well, drawn by Conky, specifically the conky-pywal theme. All these elements together with the wallpaper and the cursor, are switched to match the appearance of the current theme. The top panel has a pull-down menu, with a list of all themes.

AmOs ships with a good number of tools, but LibreOffice is conspicuous by its absence. To help users flesh out the distro, AmOs includes the Nemesis set of scripts from the ArcoLinux project. The script can install programs, kernels, and AMD and Nvidia drivers, from both the official Arch as well the Arch User repository (AUR). The distro also includes two helpers – yay and paru – to make it easier for new users to pull-in additional software from the AUR.

Another tool that the distro has borrowed from ArcoLinux is the Archlinux-Tweaktool. It's designed to customise various aspects of the distro. For instance you can use it to install additional desktop environments, tweak the display manager, configure the package manager, and more.

> "We believe AmOs is best appreciated by users who've clocked up a fair amount of Linux mileage."

The AmOs conveniences extend beyond the desktop as well. The developer has defined several command-line aliases to reduce several administration tasks, such as updating the distro, down to a single command.

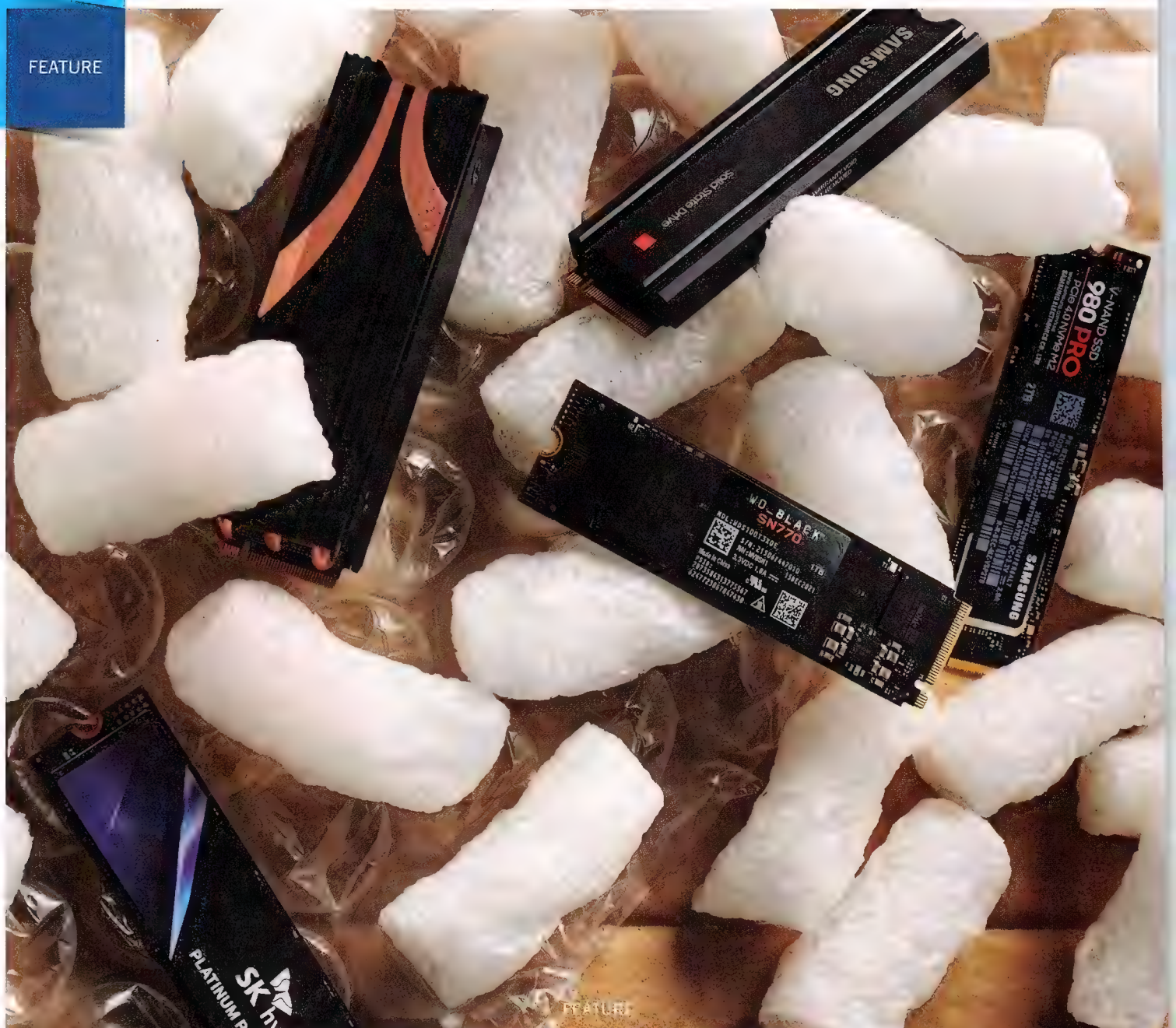
All things considered, we have mixed feelings about AmOs. Its customised desktop, the theme switcher, and the use of the Calamares installer are something that makes us want to recommend the distro to anyone as a showcase for Arch's versatility. However, some of its other conveniences, such as the Nemesis scripts and the CLI aliases, are perhaps best appreciated by experienced campaigners. Another potential red flag is the lack of documentation. As all one-man operations, we can appreciate the priority of the developer is to smoothen the rough edges in the distro, but a support infrastructure is just as important for a distro, especially for one that's pitched at beginners.

We believe AmOs is best appreciated by users who've clocked up a fair amount of Linux mileage, and can make best use of the scripts and CLI tweaks. The developer has been fairly active and has been putting out releases regularly, and we hope this momentum continues and helps AmOs carve a niche for itself.

A nicely put together derivative, with enough conveniences to project itself as the daily driver for experienced Linux users.

Mayank Sharma

In addition to the main Xfce-edition the project also produces another with the bspwm tiling window manager, cementing its intentions to appeal to the Linux connoisseur.



FEATURE

THE FUTURE OF STORAGE

As SSDs get faster and cheaper, Jeremy Laird investigates how much more flash memory has to give and whether something better is around the corner.

When the first solid-state drives (SSDs) for consumers appeared in 2008, it seemed like the problem of PC storage had been cracked for good. Finally, a fully solid-state PC was possible. On paper, even those early SSDs obliterated conventional hard drives with spinning magnetic platters when it came to most measures of performance.

But almost immediately it also became clear that the SSD was a work in progress. With a bit of use, early drives quickly became stuttering, laggy, useless bricks. More gradually, we PC enthusiasts became familiar with the inherent shortcomings of the predominant memory technology used for SSDs, namely NAND flash.

Since then, flash-based SSDs have improved beyond all recognition in terms of performance. At the same time, prices have fallen dramatically to the point where it's now routine to have a purely solid-state storage solution in a PC. Even high-performance 1TB SSDs can now be had for a little over $200 while $120 will buy you a serviceable budget model. That's pretty incredible.

That progress is set to continue for the foreseeable future as NAND flash memory is further refined. Faster, larger, and cheaper SSDs are pretty much guaranteed. Despite that, hope for a radical new technology that sidesteps the latency and endurance shortcomings of flash memory remains. Could a radical new approach to non-volatile memory be around the corner? Or is funked-up flash memory the future? Time to find out.

When it comes to solid-state storage based on flash memory, it's all about the trade-off between data density and both performance and endurance. Those three major metrics of solid-state storage prowess are intimately interlinked. Put simply, as density increases, performance and endurance fall away.

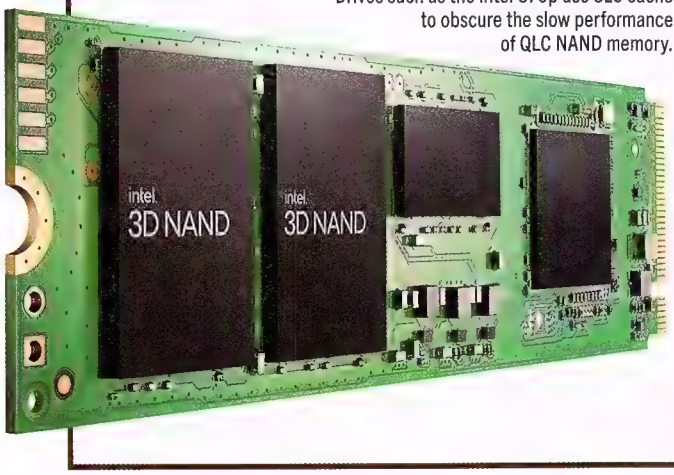
That's a bit of a pain but it all comes down to the cell structure of NAND flash memory. Currently, there are four commercially available varieties of NAND flash, SLC or single-level cell, MLC or multi-level cell, TLC or triple-level cell, and QLC or quad-level cell. Respectively, they can store one, two, three, and four bits of data per memory cell.

So far, so relatively simple. But the question follows, why does adding more cell levels or bits of data degrade both performance and endurance? To understand that, we need a grasp of how flash memory cells work. In basic terms, that involves storing an electric charge in the form of electrons between two gates. In a single-level cell (SLC), the cell is storing either a 0 or a 1, represented by the presence or absence of charge or electrons, also known as a reference voltage. That's pretty straightforward, both conceptually and in practical terms when it comes to measuring the presence or absence of charge.

As we've seen, MLC memory cells can store two bits of data. Thus an MLC cell can be in one of four states, namely '00', '01', '10', and '11'. In turn, that requires four different reference voltages or levels of cell charge to differentiate the four possible states. TLC or triple-level cells can store three bits of data – '000', '001', '011', and so on – which therefore dictates eight different cell states and requires eight reference voltages. Meanwhile, quad-level cells need 16 reference voltages to store their four bits of data.

It's obvious that as cell densities increase, so does the complexity. And then some. The critical point is that it's much easier to determine whether a cell simply contains charge or does not than it is to differentiate between 16 different levels of charge. As data density increases, errors inevitably creep in. Consequently, the workload in terms of comparison of charge states and the requirement for error correction increases exponentially with cell density. That's why performance takes a hit as cell density increases. It takes time to do all that work.

As for endurance, that hinges on the oxide layer in those aforementioned charge-storing gates. The oxide layer provides electrical insulation for the floating gate in a flash memory cell. Apply a sufficient voltage and the electrons will tunnel through the layer. But as they do so, they damage the oxide layer slightly. As the damage builds, the rate of errors during the write process increases. Eventually, the error



Drives such as the Intel 670p use SLC cache to obscure the slow performance of QLC NAND memory.

Intel's Optane tech promised so much, but simply proved too expensive.

WHATEVER HAPPENED TO INTEL'S OPTANE TECHNOLOGY?

It was all so promising...

It was once the future of computer memory. A technology that promised to be as fast as RAM and more durable than flash memory. Now it's all but dead, so whatever happened to Intel Optane?

Based on a new non-volatile memory technology known as 3D XPoint, Optane-branded drives could maintain data storage without power. But like RAM, 3D XPoint memory was addressable at the bit level. That gave it much higher IOPS performance than any flash-based technology and much lower latency. 3D Xpoint also offers spectacular endurance. For example, the 1.6TB version of the Intel Optane SSD DC P5800X delivers a ridiculous 292PB (yes, petabytes!) of write endurance. Put simply, you won't ever wear that out.

It's all the more remarkable, then, how quickly the whole project failed. 3D XPoint technology was announced in 2015 with the first Optane drives going on sale in 2017. But by late 2018, Intel and its technology partner in 3D XPoint, Micron, had already decided to part ways and dismantle the joint venture. Intel canceled its Optane drives for consumers in January 2021 and in July this year, Intel decided to entirely wind down its Optane business. Meanwhile, in March 2021 Micron confirmed that it had ceased development of 3D XPoint technology and was selling the Lehi fab used to produce Optane chips.

While it's not impossible even at this late stage that another outfit may acquire 3D XPoint in some form, it certainly looks unlikely. As far as anyone can tell, Optane and 3D XPoint are toast. But why? The simple answer is money. According to figures from Intel's official 10K SEC filing, the Optane division lost US$500 million in 2020, with 2021 thought to have generated a similarly large hole in Intel's balance sheet. It turns out that 3D XPoint memory chips were incredibly expensive to manufacture, to the point that even at the elevated prices Optane drives were selling compared to conventional SSDs, they were being marketed at a large loss. And still, they didn't really sell.

What's more, with Intel's revenues down a hefty 22 percent year-on-year in its most recent operating quarter, it's likely that the company simply couldn't stomach large losses from a subsidiary division that wasn't central to its plans for recovery. So Optane is a goner. And that's almost certainly for good.

correction algorithms used by SSD controller chips can't keep up with the errors, and the cell becomes unreliable.

That general principle applies to all flash memory cells regardless of the number of bits they can store. The problem with multi-level cells is that they store more bits per cell. So, each cell is written to more often and wears out faster. Real-world performance and endurance vary across different vendors and generations of NAND flash. But as a rule of thumb, SLC cells can be written to around 100,000 times, a process also known as a program-erase cycle, before wearing out, MLC can handle 10,000 cycles, TLC is good for 3,000 cycles, and QLC around 1,000 cycles.

Ostensibly, those figures look pretty horrifying for QLC memory in particular. In practice, it doesn't quite work out that way. Not that there are really any pure SLC consumer SSDs to buy these days, but if there were, they wouldn't necessarily have 100 times better endurance. And even if they did, it arguably wouldn't matter. Primarily, that's because modern SSDs have several technologies that effectively extend endurance, most notably wear leveling, which ensures data is written as evenly as possible across the drive, rather than hammering the same cells over and over until they fail.

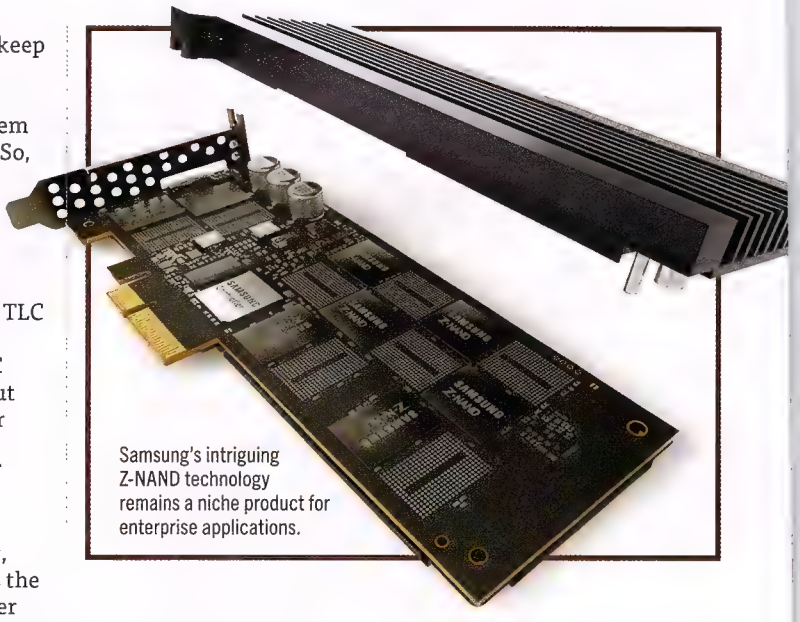
The use of 3D layered NAND, as opposed to old-school 2D planar NAND, helps too. By stacking layers of cells vertically to increase density, the individual size of the cells becomes less critical. Current 3D flash has hundreds of layers of cells stacked on top of one another. That allows for larger individual cells while still increasing data density. And large cells are more resistant to write wear. Hold that thought, we'll come back to the question of 3D memory in a moment.

First, take the Samsung 870 QVO as an example of a QLC-based SSD. In 1TB format, the 870 QVO is rated at 370TB of write endurance. That's enough for 202GB of writes each day, every single day, for five years. More realistically, the vast majority of PC usage results in less than 50GB of write traffic daily. In other words, at least in terms of Samsung's claimed 370TB rating, it's unlikely that write endurance will be an issue for all but the most demanding users.

When it comes to performance, it's a little harder to pin down just how much performance drops off as cell densities increase. Partly, that's because pretty much all SSDs use multiple mitigations to obscure the underlying performance of the flash memory cells. The most important, arguably, is known as SLC caching. The idea is simple enough, namely running a portion of the available memory cells in faster SLC or single-level mode. Most modern drives allocate a dynamic amount of the available memory as SLC cache, depending on prevailing workloads.

Using the 2TB version of Intel's QLC-powered 670p M.2 SSD as an example, that drive offers a dynamic range of between 24GB and 280GB of memory running in SLC mode. Attempt to dump hundreds of gigabytes of data onto the drive and you'll find it achieves the claimed 3GB/s of sequential throughput for around the first 280GB of transfer. At that point, the SLC cache is exhausted and the underlying performance of the QLC flash memory is exposed. Performance then drops to a range between 250MB/s and 400MB/s.

Of course, the larger the SSD, the bigger the SLC cache. The 4TB version of Sabrent's Rocket Q4, another QLC drive, offers as much as 1TB of memory running in SLC mode. That allows for an awful lot of traffic before the true performance of its QLC memory cells is exposed. All of which is, inevitably, a long introduction to the questions that have been loitering just out of view. What comes next after QLC memory and could it be so slow and so short-lived in endurance terms that it's not actually viable for real-world usage?



Samsung's intriguing Z-NAND technology remains a niche product for enterprise applications.

At first glance, flash memory capable of storing five bits per cell, known as penta-level cells or PLC, seems like a non-starter. If 16 reference voltages are problematic in QLC memory, surely the 32 levels required for PLC will absolutely batter performance and endurance in return for marginal gains in density? After all, you're only gaining 25 percent in terms of data density going from four to five bits per cell, but the charge level complexity is doubling from 16 to 32. Could PLC memory be a step too far in terms of diminishing returns?

> "When it comes to performance, it's a little harder to pin down just how much performance drops off as cell densities increase."

Certainly, the flash memory industry has gone quiet on PLC NAND memory of late. Back in 2019, Toshiba announced that it had PLC NAND test chips up and running. Late in 2020, Intel said it was on track to deliver PLC memory, too, and claimed that the technology will mean that SSDs finally hit sufficiently low cost per GB to replace old school hard disks for all mass storage. But here we are in late 2022, and there's no sign of either company releasing PLC memory

Toshiba subsidiary Kioxia offers SSDs based on its low-latency XL-FLASH, but they're seriously expensive.

Micron is putting its cutting-edge 232-layer 3D NAND into its latest Crucial SSDs.

Micron based an early computational SSD on its M500 SATA drive.

chips and Intel is now in the process of offloading its entire SSD business to SK Hynix.

An arguably more realistic time frame for the arrival of PLC tech comes from Western Digital. Last year, WD predicted that PLC memory wouldn't hit the market until the latter half of the current decade. A major reason for that is allowing time for SSD controller chips to acquire the performance required to support the extremely demanding error correction that will be necessary to support PLC memory. ARM has already released its next-gen Cortex-R82 core for SSD controllers. It's twice as fast as the previous Cortex-R8 SSD-optimised design and also doubles in maximum core count from four to eight.

SSD controller chips based on Cortex-R82 should be quick enough for PLC NAND and are expected to start appearing in late 2023. However, the first chips will be quite large and expensive, which rather defeats the object of PLC memory in bringing the cost of storage down. For that reason, it's likely that PLC will only become viable once performant controller chips have been made affordable courtesy of a couple of die shrinks. We're not expecting to see PLC drives in our PCs, therefore, until around 2028. It really is that far out.

Of course, bit levels aren't the only way to increase memory density. The other major available route is by increasing the number of layers in 3D NAND, literally stacking memory cells on top of each other. Of course, 3D NAND now dominates the industry. And it is developments in this area that are likely to not only deliver consumer SSD capacity increases but also drive performance gains.

The current state of the art in terms of layering memory cells is Micron's 232-layer TLC NAND, which has just begun shipping as we go to press. Micron reckons its new 232-layer TLC chips are capable of 2.4GT/s I/O performance, 50 percent more than its previous 176-layer technology, along with twice the write and 75 percent higher read bandwidth. The 232-layer chips also achieve a much higher data density of 14.6 Gb/mm2, up 43 percent from the 10.3Gbit/mm2 of the 176-layer generation. The improved density has allowed Micron to finally produce its first 1Tbit TLC die. That in turn means that 2TB chip packages are possible by stacking 16 of their 232-layer dies. That's in a chip package smaller than a postage stamp. Remarkable.

SK Hynix's memory chip division, recently bolstered by acquiring Intel's flash memory business, is set to have its own 238-layer tech available next year and has rough plans for 500-layer memory in 2025 or 2026 and incredible 800-layer memory around 2030. Likewise, Micron and Samsung have

COMPUTATIONAL SSDS

Are "smart" SSDs the future?

Storage devices that do their own computation – now there's an interesting idea. Not only could you reduce the overall load on the CPU, freeing up resources for other tasks. The flow of data back and forth between storage and the CPU could also be minimised.

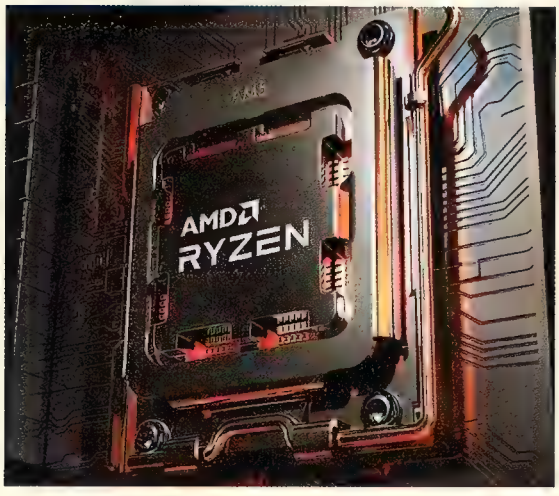
If nothing else, data transfers use up a lot of energy. ARM estimates that over 60 percent of the energy consumed in computing gets hoovered up just moving data in and out of storage. And energy consumption is becoming an ever more sensitive issue for a whole range of reasons. So, what if you did the computation on the drive itself and didn't have to move the data over to the CPU at all? Not only would you save power, but as you add drives, you add performance. It's all win, win, right?

So far, this concept has largely been reserved for enterprise applications. Micron first mooted the idea back in 2013, modifying its mainstream M500 SSD with an ARM processor that could search MySQL databases. Apparently, with enough of the drives installed in a server, the CPU load for such searches dropped from 100 percent to just one percent while roughly cutting power consumption in half. Impressive.

The idea has since gone from concept to reality. Samsung, for instance, is now on its second generation of retail-available computational storage devices, known as Samsung SmartSSD. More specialised computational SSDs are expected in the future, with dedicated hardware for tasks such as encryption and video encoding and streaming.

Such drives would mean large installations of numerous expensive servers installed locally for delivering services like streaming video are no longer needed. Instead, you can have one or two servers and a stack of much cheaper computational SSDs.

All of which begs the question of how this might apply to client PCs. Software support is obviously key and, for now, that's restricted to enterprise applications. What's more, power consumption, even in the current context of an energy crisis, isn't an absolutely critical factor for desktop PCs. But for laptops and tablets? Now there's an application where dramatic reductions in power consumption could come in handy when it comes to battery life. Actually, we're surprised that computational SSDs for portable PCs aren't already a thing. One to watch for the near future? We think so.



AMD's Ryzen 7000 CPUs will be the first to offer native M.2 PCIe Gen 5 support.

PCI EXPRESS TRAIN

Gen 5 is almost alive...

Remember the good old days of ribbon-like IDE cables, jumpers, and maximum bandwidth measuring 100MB/s? Back then, the introduction of SATA in 2003 was pretty dramatic stuff. It nearly doubled bandwidth, debuted a slick new physical connector, and even supported hot swapping.

Pretty quickly, the theoretical peak bandwidth of SATA quadrupled to 750MB/s and storage performance was really up and running. Ever since then, that relentless progress has kept on coming. Today, the latest M.2 SSDs connect via a PCI Express 4.0 quad-lane interface supporting up to 8GB/s of bandwidth – more than RAM or system memory offered back when those IDE drives were being replaced by the first SATA HDDs.

Anyway, PCIe Gen 5 drives are already supported on Intel's latest 12th Gen Alder Lake CPUs, albeit with some limitations, and AMD is adding native PCIe Gen 5 M.2 storage support with its new Ryzen 7000. With PCIe Gen 5, theoretical throughput increases to a giddy 16GB/s for a quad-lane M.2 SSD, with real-world sequential performance in the region of 14GB/s.

That, of course, will not be the end of the story. PCIe Gen 6 will double performance once again, up to 32GB/s theoretical for an M.2 drive and the thick end of 30GB/s actual usable bandwidth. The full specification of PCIe Gen 6 was published earlier this year and the usual rule of thumb is that supporting hardware appears a year to 18 months later.

However, with PCIe Gen 5 SSDs only just about to hit the market, we suspect the delay could be a little longer, more like two to three years. Certainly, AMD won't have PCIe Gen 6 support until its Zen 5-based CPUs arrive.

As for Intel, we're not expecting either its next-generation Raptor Lake CPUs, due later this year, or Meteor Lake, due in 2023, to support PCIe 6.

"The full specification of PCIe Gen 6 was published earlier this year and the usual rule of thumb is that supporting hardware appears a year to 18 months later. "

roadmaps up to and including at least 500-layer flash memory laid out for the next few years.

Exactly how dense and how fast flash memory will be by the time it hits the 500-layer mark is a matter of speculation. However, if the gains Micron made with its latest 232-layer chips over 176-layer technology are at all indicative, 500-layer memory density and performance will be truly spectacular. Roughly, we'd expect SSDs capable of something around 30GB/s of raw bandwidth and offering around three times the capacity as today's drives to be available within four to five years. By the end of the decade, all bets are off. If 800-layer chips really are available, the speeds and densities are going to be bonkers.

If 3D NAND flash is likely to continue for the foreseeable future as the dominant storage technology, are there any alternatives on the horizon? Sadly, Intel's Optane drives are pretty much toast. You can read the boxout (on page 50) to find out more, but suffice to say, Optane is no longer a goer.

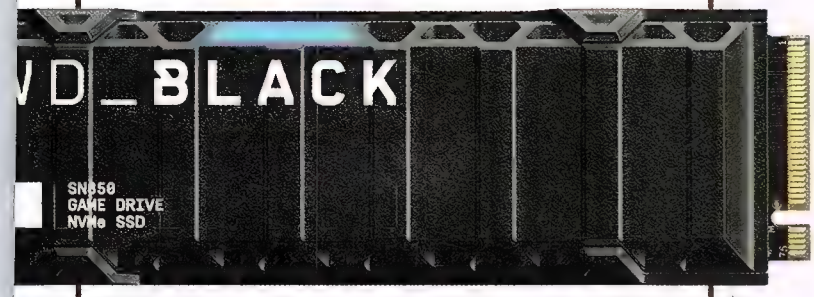
Right now, the only other remotely mainstream and available technology is in fact a derivative of NAND flash. The idea is to address the main weakness of flash memory, namely latency. To do that, both Samsung and Toshiba have taken a similar approach, which is based on a tweaked version of existing flash memory running in SLC or single-level cell mode. Samsung calls its take Z-NAND, while Toshiba's flash memory subsidiary Kioxia brands its technology as XL-FLASH.

Kioxia reckons its XL-FLASH reduces latency down to the 20µs to 5µs range – that's much better than today's typical high-performance TLC NAND memory, which is nearer 100µs. Though it's not as quick as Intel's defunct Optane tech, which in its final iteration was below 6µs. Samsung makes similar claims for its Z-NAND, pegging latency at around 20µs. Of course, thanks to running in SLC mode, both Z-NAND and XL-FLASH also offer much better endurance than the TLC and QLC flash memory used by consumer SSDs today. The problem, however, is that SLC memory is inherently less dense and so more expensive. That's probably why both Z-NAND and XL-FLASH remain niche products. It's also why they're unlikely to be the next big thing in consumer SSDs. Like Intel Optane, they're just too expensive.

However, there is one NAND derivative that looks more promising and it's known as X-NAND. The sales pitch from X-NAND's creator, a memory start-up founded in 2016 called NEO Semiconductor, is that it combines the data density and low cost of QLC memory with as good or even better performance than SLC flash. That is one heck of a claim.

NEO says X-NAND achieves this by reducing the size of flash memory page buffers by fully 94 percent. That matters because it enables the plane count in a flash memory die to be increased from two or four to as many as 64. If we've lost you at this point,

A new technology known as X-NAND promises the density of QLC NAND similar to that of the Sabrent Rocket Q4 combined with the performance of SLC memory.



High-performance PCIe Gen 4 SSDs, such as the WD_Black SN850 pump out over 7GB/s of raw bandwidth.

a plane is a collection of NAND cells that can be read or written to in a single operation. Critically, these plane operations run in parallel. In other words, an X-NAND die can run 64 plane operations while conventional QLC NAND runs between two and four. Hey presto, that's a massive jump in I/O performance. All told, NEO claims X-NAND offers as much as 27 times the sequential read performance of existing QLC memory, 15 times the write performance, and around three times the random access performance.

X-NAND can also operate in SLC mode and offers similar performance benefits over SLC NAND as it does over QLC NAND when operating in QLC mode. In theory, that means you can have the choice of a big, cheap QLC drive that's as fast as an SLC drive without having to reduce capacity to allow for a large, fast SLC cache. Or you can have something exotic in terms of performance if you're willing to reduce capacity and run some SLC cache.

All very impressive. So what's the catch? Based on the most recent information we can find, NEO Semiconductor has a total of 10 employees and all of the above is theoretical. The chips don't actually exist. Instead, NEO is likely hoping to license X-NAND to one of the big boys in NAND manufacturing, such as Micron or Samsung. That said, NEO did win the Most Innovative Flash Memory Startup award at the 2020 Flash Memory Summit, so the industry is clearly impressed. But SSDs with X-NAND are several years away at minimum, if the technology does indeed ever deliver on the impressive promise.

Those NAND flash derivatives aside, the truth is that there is no obvious alternative to NAND on the horizon. Granted, there are numerous candidate technologies to be the next major advance in non-volatile memory. Phase Change Memory (PCM), Resistance RAM (ReRAM), Ferroelectric RAM (FRAM), Magnetic RAM (MRAM), and Spin Transfer Torque MRAM (STT MRAM) are among the technologies that already exist and have some level of actual commercial availability. Looking further, carbon nanotube memory or NRAM is also under development.

However, none of these have moved out of niche enterprise applications into consumer products that you might be able to buy for your PC. The closest yet is Phase Change Memory courtesy of Intel's Optane SSD, which was fleetingly available for client PCs. Of the other candidate techs, the broad consensus is that Resistance RAM or ReRAM (sometimes also referred to as RRAM) is the most likely to succeed flash memory. It's another non-volatile memory tech that promises to solve the latency problem of NAND flash and also bit-level rather than page-level data addressing, which would dramatically improve performance. But thus far, not a single company has announced plans for a consumer ReRAM product, let alone launched one.

For at least the next three to four years, all the progress in PC storage will almost certainly be delivered by those more advanced 3D TLC chips with more and more layers, probably scaling to 500 layers toward the end of that time frame. As we've seen, that's not necessarily a bad thing. Yes, flash memory does have inherent limitations, especially when it comes to latency. But each new generation of 3D TLC technology will chip away at the latency limitations, improve performance and add capacity.

In that sense, flash memory is a bit like LCD technology in monitors and laptop displays. Conceptually, LCD is inherently a bad solution for a full-colour motion picture display. It's transmissive, creating major problems in terms of contrast and viewing angles, while the need to physically move liquid crystals results in a poor response. But over the years, those technical limitations have been relentlessly refined to the point that, today, thanks to innovations, such as mini-LED backlights and pixel overdrive, the latest LCD panels are capable of incredible contrast and remarkable quick response.

Much the same applies to flash memory. It's fundamentally flawed but it's getting better all the time. So, yes, it is disappointing that Intel's Optane failed and that a low-latency alternative to flash memory has yet to emerge. But the short- to medium-term outlook for storage is still at least as promising in terms of progress, if not more so, than the likes of CPU or GPU tech. If larger, faster, and cheaper SSDs are a measure of that progress, there's plenty to look forward to. We guarantee it. ■

"The sales pitch from X-NAND's creator, a memory start-up founded in 2016 called NEO Semiconductor, is that it combines the data density and low cost of QLC memory with as good or even better performance than SLC flash. That is one heck of a claim."

Early SSDs including the Intel X25-M quickly proved problematic.

FEATURE

Tech that changed Australia (and the world) part 5. Listening to the stars

With WWII now over, the CSIR's Radiophysics division was ready to turn its new radar technology towards the stars – and broaden our understanding of the universe. Darren Yates writes.

It's a sobering thought that many of the world's greatest discoveries and inventions have come about through war or the threat of war. The development of radio-direction and ranging – or 'radar' – is an example, becoming a universal electronic warfare tool during WWII. But even at the end of the war, the concept of radar had barely been around for a decade, yet the chance to turn radar antennas towards peace-time discoveries was already on the cards in Australia – a move that would put us at the forefront of the emerging science of radio-astronomy.

"Sydney was considered a prime target for attack during WWII, a fact that led to the tall sandstone cliffs of Dover Heights in the city's east becoming home in 1940 to a defence radar installation"

The Mills Cross radio-astronomy antenna array at Fleurs (Kemps Creek). (Image credit: CSIRO Radio Astronomy Image Archive)

Humble beginnings

Sydney was considered a prime target for attack during WWII, a fact that led to the tall sandstone cliffs of Dover Heights in the city's east becoming home in 1940 to a defence radar installation used by the Council of Scientific and Industrial Research (CSIR)'s new Radiophysics division (the CSIR was later renamed the Commonwealth Scientific and Industrial Research Organisation – CSIRO). In 1942, a second station was established by the RAAF at Collaroy Plateau, on Sydney's northern beaches.

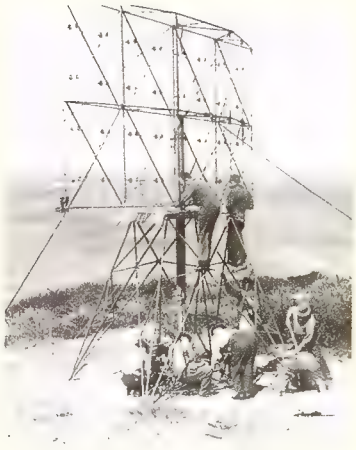
But during the war, planes and ships weren't the only detections made by radar sets – they also picked up weird sources of radio 'noise'. What's more, they were reportedly coming from the sun. Near the end of the war, New Zealand scientist Elizabeth Alexander had the radar station on Norfolk Island point its set towards the sun, with strong signals recorded over multiple days. This report reached the CSIR and it was decided Australia would join the hunt for solar radio-waves.

Australia's first female radio-astronomer, Ruby Payne-Scott. (Image credit: Peter Hall, CC BY-SA 3.0).

At sunrise on 3 October 1945, the first detection of solar radiation on the 200MHz frequency band was recorded at Collaroy Plateau. Some of Australia's leading minds in Joe Pawsey, Ruby Payne-Scott (Australia's first female radio-astronomer) and Lindsay McCready were quickly making new world-class discoveries.

For example, they discovered, with the help of the Mt. Stromlo observatory in Canberra, that fluctuations in radio emissions from the sun coincided with sun-spot activity on the sun's surface. Their findings were published in the highly-regarded journal, Nature, in 1946.

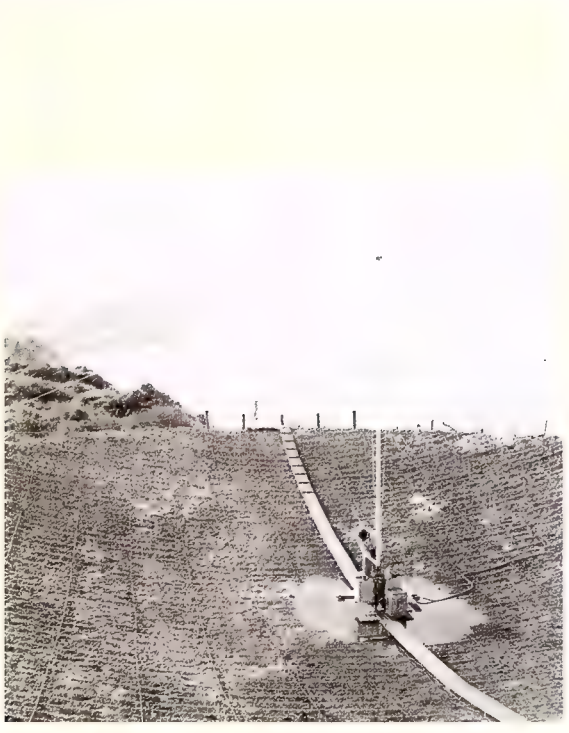
This research continued until early-1946, when the Collaroy site was eventually decommissioned. However, with the Dover Heights radar still operating, research quickly moved there and continued in earnest in the years ahead.

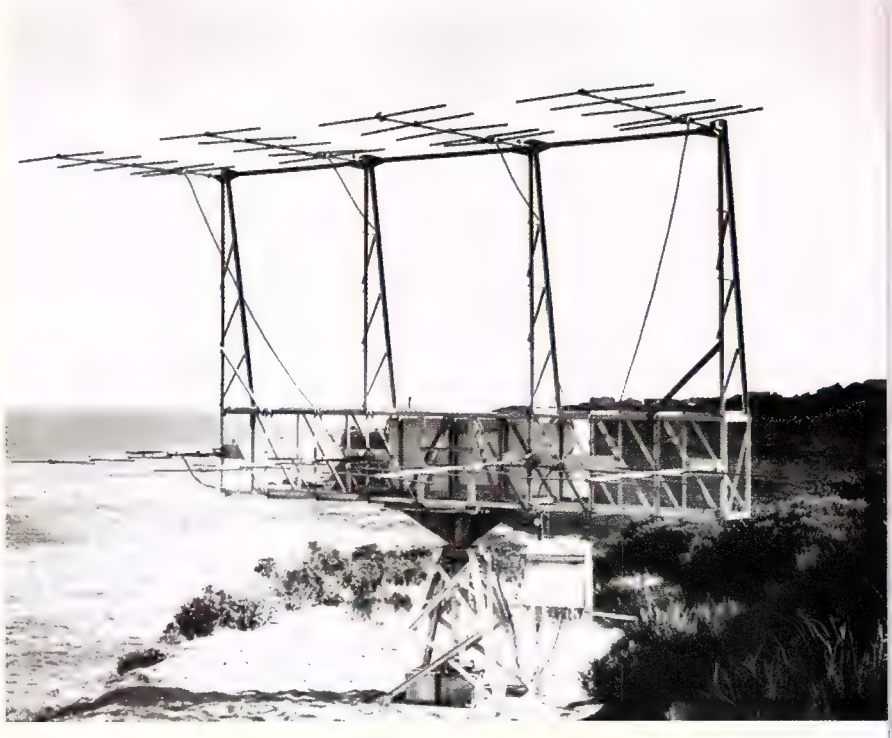


The first lightweight radar unit being deployed at Dover Heights in September 1942. (Image credit: CSIRO Radio Astronomy Image Archive)

Beyond the solar system

In fact, Dover Heights became a hive of activity, involving more of Australia's most respected scientists – names such as John Bolton, Gordon Stanley and Bruce Slee. One of the first changes after the war was the introduction of directional 'Yagi' antennas (named after Japanese antenna genius, Hidetsugu Yagi) that would better-allow scientists





to identify the source of radio-waves detected. Yagi antennas look like elaborate clothes-hangers and almost every home today uses one to pick up free-to-air TV – the first small examples at Dover Heights were even built from left-over war-materials, yet they were instrumental in producing the first sky-surveys of radio emissions. Over time, the Yagi antennas were augmented with small 'dish'-style radio-antennas, as scientists continued to experiment with ways to further their electronic gaze into the galaxy.

A hole in the ground

But by 1951, it became clear that the team needed a bigger antenna to peer into the universe with more resolution. The problem was, as with most scientific endeavours at the time, money was tight. The now-CSIRO couldn't afford to fund another large-scale Yagi antenna, so John Bolton came up with a brilliantly simple and thrifty alternative – dig a hole in the ground. To be fair, it wasn't quite that simple, but it also wasn't a lot more complicated either.

Located to the north-west of the Dover Heights station, Bolton, Stanley and Slee dug out a 22-metre diameter dish-shaped hole in the sand. They layered it with reclaimed metal strips to reflect radio waves and placed an antenna mast in the middle to pick them up. Not only did it work, this typically-Australian example of make-do ingenuity was now the second-largest radio telescope in the world.

In 1953, having proved its worth, the antenna was extended to 24-metres and lined with concrete. It was during this time that the antenna achieved its greatest claim to fame that's still relevant today.

The centre of the galaxy

In 1951, Australian scientists Jack Piddington and Harry Minnett using the CSIRO's then-facility at Potts Hill in Sydney's inner-west had found a strong radio source coming from a location in the constellation of Sagittarius in our Milky Way galaxy. This was later confirmed using the hole-in-the-ground antenna at Dover Heights. However, the Dover Heights sky-survey also discovered that this location (later dubbed 'Sagittarius A') was the exact centre or 'nucleus' of the galaxy. The discovery was published in Nature in 1954.

However, it was also Dover Heights' last hurrah – the station was closed in 1954 and Fleurs, the site of a WWII-era airstrip near Kemps Creek in Sydney's west, took over. At Fleurs, the 450-metre long 'Mills Cross' antenna array (named after its inventor, Australian engineer Bernard Mills) catalogued the sky, discovering over 2,000 sources of radio waves.

But in 1958, Dover Heights ensured its place in history when the International Astronomical Union (IAU) selected Sagittarius A as the coordinate-centre of the galaxy still used by astronomers today.

Sadly, none of these Sydney sites remain today, however, a replica Yagi antenna now stands as a research memorial at Dover Heights.

Nevertheless, these discoveries continue to be of huge importance today – further analysis by U.S. astronomers found a distinct compact radio-wave source in 1974 at the same location, dubbed 'Sagittarius A*'. By 2009, researchers believed this source was the location of a black hole and in May 2022, the first images captured by the Event Horizon Telescope of the black hole were released to the world.

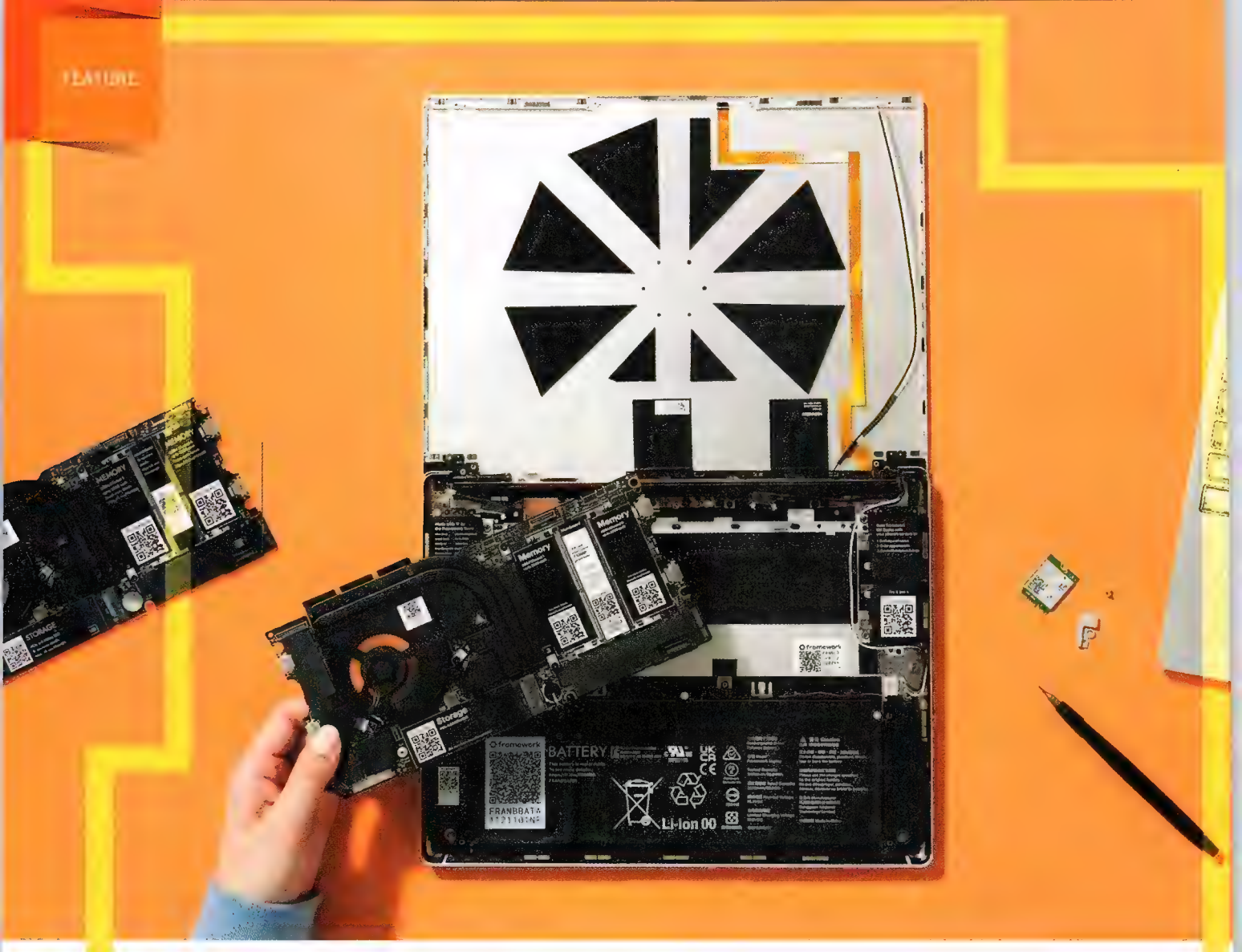
Back to the future

It's important to remember, too, in the context of this series, that many of these early Australian discoveries were made using electron-valve technology – it wouldn't be until the late-1950s that transistors began taking over, further showcasing the skill inherent in our technology heritage.

Today, Australian physicists continue their latest-technology research, including through the Stawell Underground Physics Laboratory in Victoria, which will conduct experiments next year hoping to discover the illusive universe-building substance, 'dark matter'. Meanwhile, Australia remains at the forefront of radio-astronomy, as one of the partners of the NASA-led Artemis program to return to the moon in 2024. But next time, we 'dish' up humans' first trip to the moon and one of Australia's great scientific feats, when a few Aussie scientists in the middle of a New South Wales sheep paddock helped 600 million people around the world watch a man climb down a ladder. ■

Above left: The original 21.9-metre 'hole-in-the-ground' radio-telescope at Dover Heights. (Image credit: CSIRO Radio Astronomy Image Archive).
Above: An eight-element Yagi antenna at the Dover Heights station. (Image credit: CSIRO Radio Astronomy Image Archive)

The Sagittarius A* supermassive black hole (found at the galaxy-centre located using the hole-in-the-ground antenna at Dover Heights). (Image credit: EHT Collaboration, CC-BY 4.0).



FEATURE

The D.I.Y future

Framework aims to solve the issue of tech waste, as Bennett Ring examines the upgradeable laptop that's shaking things up.

Above: The CPU upgrade modules are a complete unit including PCIe storage and cooling, plus the CPU of course.

Today's laptops are locked up tighter than Fort Knox, keeping out intrepid DIYers with their soldered CPUs, integrated batteries and threats of voided warranties. If you're lucky, you can swap out the memory, storage and Wi-Fi modules, but that's it. Considering today's batteries can potentially only have a useable lifespan of two or three years if driven daily, this single failure point alone is enough to force an upgrade of the entire device. The result is a rapidly growing tech trash problem, not to mention many bruised bank accounts.

Sadly, manufacturers are now addicted to the profit-earning cycles of forced obsolescence. It's not that they can't build a laptop with a removable battery – they simply don't want to, as it would see a huge drop in sales. The same is true of our mobile phones and tablets, which are prone to even more extreme planned obsolescence.

Make it upgradeable

One company is trying to change all that. Framework released its first upgradeable laptop back in July 2021, which as of this month is available to Australians. Founded by the former head of Hardware at Oculus, Nirav Patel, the company's mission is simple – deliver a fully upgradeable laptop. Patel told *APC* during a recent interview, "We're here to prove that this model, of upgradeable laptops and other devices, is good for consumers."

The result is the Framework laptop. From the CPU to the display to the power pack, every single piece can be swapped out.

Of the three versions which have just been made available to Aussies, we find the DIY edition the most interesting, which sells for AU$1,279. For this price you get an i5-1240P CPU at its heart, housed in a chassis big enough for the 13.5in 2256 x 1504 replaceable display. However, you'll need to bring your own storage, memory and OS for that price, but everything else is included.

Early reviews of the Framework have been very positive, but there is one caveat – upgrading the combined CPU/motherboard package is quite costly, as today's mobile CPUs are soldered into the socket. To

FRAMEWORK WASN'T FIRST

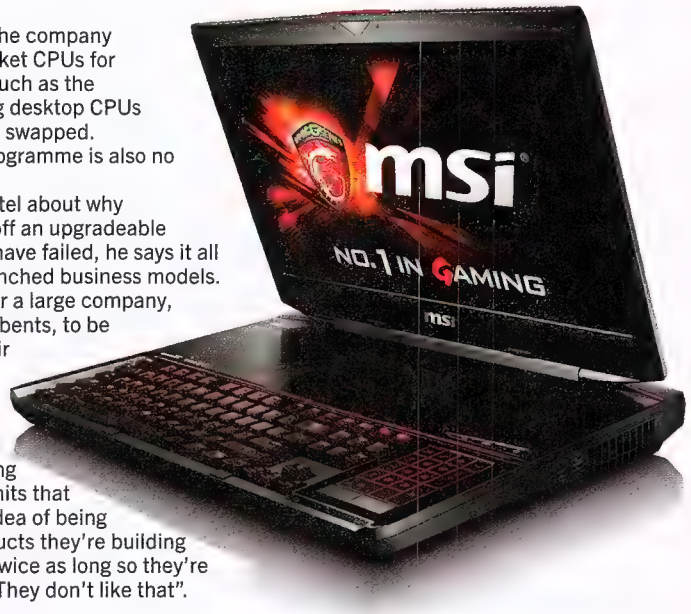
Some of the biggest PC manufacturers have taken a taken a stab at modular laptops, and the end result has always been a flop.

Alienware's Area 51m modular laptop ditched the soldered-socket approach and instead used a standard LGA 1151 socket. The company even developed its own graphics card interface to allow for swappable GPUs, called Dell Graphics Form Factor (DGFF). Unfortunately the mainboard wasn't upgradeable, and GPU upgrades were limited to within the same generation of GPU (i.e. from a 2070 to a 2080). The result? It flopped hard, and the Area 51 series is no longer modular.

MSI also had a go, albeit in a vastly more limited way. In 2015, the company's Titan series of laptops offered GPU upgrades, but owners had to send their laptop back to the factory to get one installed. Promised upgrades didn't eventuate, leaving many owners upset about broken promises. The programme ended when Nvidia rolled out the GeForce 20-series of GPUs, which were not compatible with the earlier Titan laptops.

Around the same time MSI promised GPU upgrades, premium PC maker Origin offered the same for CPUs. The company ditched soldered-socket CPUs for some of its laptops, such as the EON15, instead using desktop CPUs that were more easily swapped. Unfortunately this programme is also no longer available.

When we asked Patel about why Framework can pull off an upgradeable laptop where others have failed, he says it all comes down to entrenched business models. "It is just very hard for a large company, like the big PC incumbents, to be able to transform their business models to focus on the customer lifetime experience, as opposed to maximising the number of new units that they're selling. This idea of being able to take the products they're building and make them last twice as long so they're selling half as many. They don't like that".



Above: MSI's GT80 Titan laptop had an upgradeable GPU, but the concept never really caught on beyond this model.

upgrade to an i7-1185G7/ motherboard kit costs $1,089, giving us a good idea of how much premium CPU upgrades will cost in the future. However, other components which regularly need replacing are much more affordable. A new battery is a mere $95, a touchpad or keyboard $60, while a display fetches $279. The savings afforded by upgrading piece by piece are obvious.

Thanks to their beautifully designed interior, which utilises magnetic modules and QR-coded components, swapping out Framework pieces is a task that even a novice PC builder can tackle. Patel explains, "We've started to see a lot of people, who have never been inside of a computer before, now ordering the Framework laptop. They followed the guide and it worked. They realised that it's actually not hard, it was really just a mental barrier".

The future

Framework has its work cut out for it though, as it's not the first to market with a laptop that can be easily repaired or upgraded. Many consumers have been burnt in the past, leading to significant doubt around whether this business model is feasible. But with record inflation leading to tighter purse strings, as well as growing awareness around the issue of tech waste, consumers are more motivated than ever to make their devices last. According to Patel, laptops are just the beginning. "Once consumers become accustomed to upgrading their laptop, they're going to look next to their laptop, at their phone, and ask 'what's going on?'"

This is just the beginning

In the early days of mobile phones, swapping out the battery was a simple affair, with many models even including a spare battery in the box. Today's phones are a vastly different proposition, with battery changes either impossible or deemed a warrantee-breaking proposition. With most manufacturers only guaranteeing the battery to hit 20 percent of its original capacity in a mere two to three years, users are forced to upgrade the entire phone due to this limitation, yet the battery only costs 20 percent of the manufacturing cost. The same battery issues that plague mobile phones are found in the tablet world, and it leads to an immense amount of tech waste.

According to Framework's Founder, this sealed-box approach is a needless limitation caused by profit. Patel said, "If you look at the Framework laptop, there's a lot of creative design and development that we've done, but there wasn't a lot of core invention. There wasn't a need to build some totally new technology to enable this. This is not a technology problem. It's been limited by profits, and we see this across nearly every category where batteries are sealed."

We asked Patel if he had any plans to roll out the Framework philosophy to phones or tablets, and while his response was coy, it was also encouraging. "We definitely see interesting opportunities in the future for us to go there. Many of these are very challenging from a go-to-market perspective and have graveyards that are much more populated than even the laptop space. But when consumers start to see products that have replaceable batteries like the Framework, they are going to demand that in other products". ■

"If you look at the Framework laptop, there's a lot of creative design and development that we've done, but there wasn't a lot of core invention. There wasn't a need to build some totally new technology to enable this. This is not a technology problem."

Wipe your DIGITAL FOOTPRINT

There's more of your data on the web than you realise, which leaves you exposed to hackers, snoopers and scammers. Robert Irvine explains how to erase your personal info before it's too late.

WHAT YOU CAN DO

- Stop third-party tools accessing your online accounts
- Find out how to close your account with any website
- Remove your phone number and address from Google
- Hide details of items you've bought from Amazon
- Wipe your viewing activity from streaming services
- Delete recordings of your voice from smart assistants
- Erase posts in bulk from social-media sites and apps

Unlike in real life, where most of the things you say and do eventually fade from memory, the web never forgets. Your digital footprint – all the data you've shared online and that's been shared about you – never fades, but just keeps growing. Details of everything you've done online, and personal information you guard closely offline, are spread across the internet for strangers to see and use however they want.

The availability of this data isn't just embarrassing but potentially dangerous, because it compromises your privacy and leaves you vulnerable to hackers, scammers and data breaches.

You may be vigilant these days about choosing strong passwords and refusing third-party tools access to your accounts, but were you so careful 10 or 20 years ago? While you've probably forgotten many of the sites, services and apps you've signed up with over the years, they won't have forgotten you and may be sharing your information with other companies.

In this feature, we explain how you can wipe your digital footprint and reclaim personal data you may not even realise was still on the web. We don't mean clearing cookies from your browser or blocking ad trackers – which we've covered in previous issues – but digging deep into your online past to delete, disconnect and disable everything that threatens the privacy and security of your online life today, and into the future.

DISCONNECT & CLOSE OLD ACCOUNTS

DISCONNECT FORGOTTEN TOOLS FROM YOUR ACCOUNTS

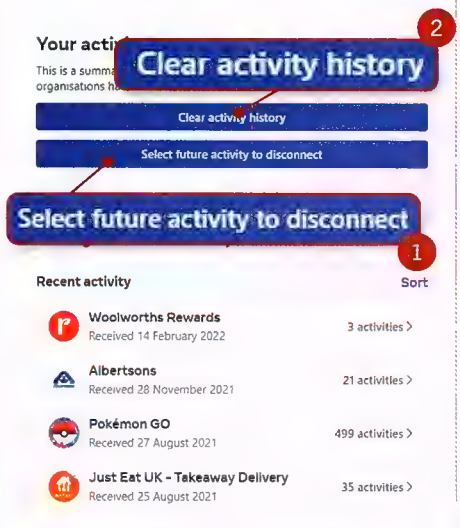
Many websites and apps let you sign up (and in) using your Google, Microsoft, Apple or Facebook account. This saves you the time and hassle of registering with your email address and coming up with a new password. The downside to this convenience is that it allows third-party tools to access your personal data long after you've actually stopped using them.

You may not even remember which services you've connected to your account over the years, which puts you at risk if they start abusing that privilege and collect more than just your basic profile information.

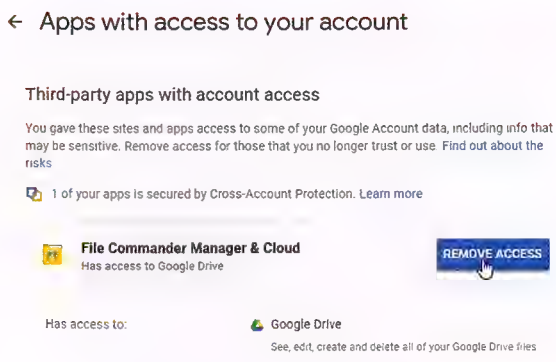
To disconnect forgotten tools from your Google account, go to the Security page at **www.snipca.com/42791**, scroll down to 'Third-party apps with account access' and click 'Manage third-party access'. Here you'll see a list of all the sites and apps you've linked to your Google account, and details of the data they can access. Some may be secured by Cross-Account Protection, which means Google will alert you to suspicious activity, but older tools are less likely to have this. Select entries you no longer trust or use and click Remove Access (see screenshot above right) to disconnect them.

To remove potentially invasive tools from your Microsoft account, log into your 'Privacy dashboard' at **www.snipca.com/42793** - you may need to enter a security code to verify your identity. In the 'More privacy settings' section, click 'Apps and services', then select an entry to see what data that tool can access. Click 'Remove these permissions' to plug the privacy hole.

To disconnect third-party tools from your Apple account, sign in at **www.snipca.com/42794** and go to Security then 'Apps & Websites using Apple ID'. Select 'Manage', then click 'Stop using Apple ID' next to an unwanted entry. Alternatively, on your iPhone or iPad, open the Settings app, tap your name then 'Password & Security' and choose 'Apps Using Your Apple ID' to review and revoke permissions.



Stop Facebook sharing your data with other companies – and vice versa.


Apps with access to your account
Third-party apps with account access
You gave these sites and apps access to some of your Google Account data, including info that may be sensitive. Remove access for those that you no longer trust or use. Find out about the risks
1 of your apps is secured by Cross-Account Protection. Learn more
File Commander Manager & Cloud
Has access to Google Drive
REMOVE ACCESS
Has access to:
Google Drive
See, edit, create and delete all of your Google Drive files

Left: Click 'Remove Access' on Google's Security page so unwanted apps you've linked to your account can't access your details.
Below: Just Delete Account explains how to close your accounts for a huge range of online services .

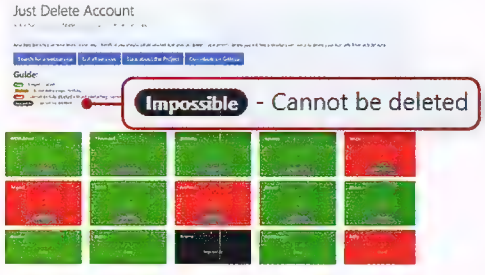
Facebook is the worst offender for letting tools access your data long after they need to. It also collects information about you from websites and apps it interacts with. To address these privacy concerns, click your profile picture in the top-right corner of the Facebook website and choose 'Settings & privacy', then Settings. Select 'Apps and websites' on the left and click the Remove button next to any unwanted entries.

Next, click 'Your Facebook information', then the View button next to 'Off-Facebook activity' and choose 'Explore activity'. Here you'll see a long list of sites and apps that share your data with Facebook, and the number of interactions they've had. Click 'Select future activity to disconnect' (1 in our screenshot left), choose all the companies whose access you want to block, then click Disconnect. You should also click 'Clear activity history' 2 to wipe any data they've already shared with Facebook.

CLOSE ONLINE ACCOUNTS YOU NO LONGER USE

You've undoubtedly signed up for lots of sites, services and apps that you no longer use, which means companies you've forgotten about still know lots of things about you. As well as your name and email address, this may include your date of birth, home address, phone number and information about your interests, friends and family. Closing these old accounts will help you shrink your web footprint, and ensure your data doesn't fall into the hands of hackers and snoopers.

The easiest way to distance yourself from your online past is to visit



Just Delete Account (**www.snipca.com/42796**), which provides instructions and direct links for closing inactive accounts with more than 1,500 online services. Browse the alphabetical list on the homepage or search for a specific service you want to leave. Helpfully, entries are colour-coded to show you how straightforward it is to delete your account: green for easy, yellow for medium (some extra steps involved), red for hard (requires contacting customer services) and black for impossible (see screenshot above). Members of the latter group include Canva, Evernote, Match, Now TV and PayPal – although technically you can close your account, it will never be deleted. It's also worth installing the Just Delete Me extension in Chrome and other Chromium browsers (**www.snipca.com/42803**). Although it hasn't been updated for two years (and neither has its parent website), this helpful tool provides a toolbar button that takes you directly to the account-deletion page for the site you're viewing when you click it.

CHECK IF YOUR ACCOUNTS HAVE BEEN HACKED

The most urgent accounts to close are those that have been affected by data breaches, because hackers may already have gained access to your personal information - particularly if you use the same password across several sites. Search for your email address or phone number at Have I Been Pwned (**www.snipca.com/42797**) to discover if your logins have been leaked, and which companies were affected. You can also click 'Notify

Experian.com
Organization: Experian.
Request account deletion or a copy of your personal data.
Use this free service to send GDPR, CCPA and LGPD data requests.
This service is not affiliated with Experian (find out more about us).
Fill in the following form to creates a Data Request email which you can then review and send. For more information read our Questions.
Request type *
Delete my data
Send me a copy of my data
Full name *
Charlie Quick
Regulation *
DPA (UK)
GDPR (European Union)
DPA (UK)
CCPA (California)
LGPD (Brazil)
1
Delete my data
2
DPA (UK)

Send data brokers such as Experian an official request to delete accounts they've created in your name.

me' to receive alerts when your accounts are compromised.

For a second opinion, try MyPwd (**www.snipca.com/42798**). This goes further than Have I Been Pwned by emailing you details of which passwords were included in breaches (see screenshot above).

Your web browser may also warn you if your login details are compromised. Chrome lets you check your passwords at **chrome://settings/passwords**, while Edge has an option to 'Show alerts when passwords are found in an online leak' in its Passwords settings. Firefox accounts are protected by Mozilla's Firefox Monitor tool, which is powered by Have I Been Pwned, and detects if your email address has been involved in a data breach. You can use this tool in any browser by visiting **www.snipca.com/42802**.

Once you've deleted your accounts with hacked websites, make sure you change any passwords that were affected for sites you intend to keep using.

DELETE YOUR ACCOUNTS FROM DATA BROKERS

Closing an account with an online service you signed up for is usually quite straightforward. Even if you can't remember your username or password, you can usually request an account-reset email or text message. More difficult to delete – and more worrying in terms of your online privacy – are the accounts that data-broker companies such as Experian, Equifax and Acxiom create on your behalf. These gather information about you from various sources to build a profile they can sell to other companies, for purposes including advertising and marketing, political campaigning and even law enforcement.

Thankfully, the EU's GDPR rules have forced these companies to be more transparent about how they collect your data, but you may still want to wipe what they already know about you. DataBrokers.org (**www.snipca.com/42799**) lists the top 10 biggest collectors of your personal information. Click the name of a company, select 'Delete my data' (1 in our screenshot above) and enter your full name, then choose GDPR in the Regulation dropdown menu 2. Click 'Review and Send' to open a deletion-request message in your default email client. Once you've sent this, the data broker has 30 days to comply with your request, though it may ask for additional details to help identify you.

DELETE YOUR DATA FROM ONLINE SERVICES

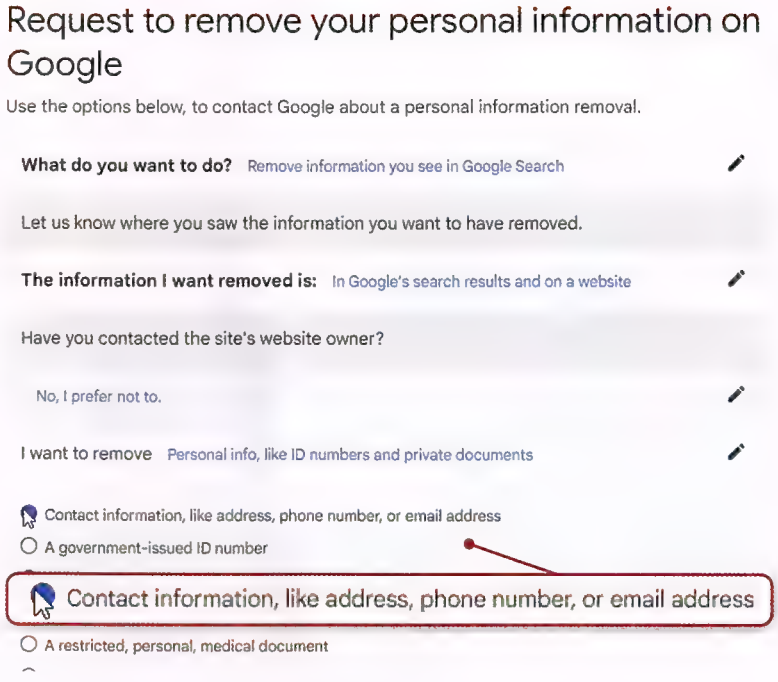
REMOVE YOUR PHONE NUMBER AND ADDRESS FROM GOOGLE

In April this year, Google introduced welcome new options for requesting the removal of your contact data from its search results.

Previously, you could ask Google to remove certain information that could identify you, including bank account and credit card numbers, government ID data and explicit or defamatory content about you. This has now been expanded to include deletion of your phone number, email address and home address from Google results, though they won't be wiped from the wider web.

Go to the support page 'Remove select personally identifiable info or doxxing content from Google Search' (**www.snipca.com/42806**) and click 'Start removal request'. On the next page, specify whether the data appears only in Google's search results or also on a website, and whether you've contacted the site's owner. Under 'I want to remove', select 'Personal info, like ID numbers and private documents', then 'Contact information, like address, phone number, or email address' (see screenshot above right) and use the form that opens to provide further details. These should include the URLs of any pages on which your contact data appears and the search terms that find it. You can also provide screenshots and 'additional context'.

Tick the legal box, click Submit and Google will email you to confirm it has received your request. Once investigators have reviewed your case, Google will let you know whether your removal request has been accepted or denied.


Request to remove your personal information on Google
Use the options below, to contact Google about a personal information removal.
What do you want to do? Remove information you see in Google Search
Let us know where you saw the information you want to have removed.
The information I want removed is: In Google's search results and on a website
Have you contacted the site's website owner?
No, I prefer not to.
I want to remove Personal info, like ID numbers and private documents
Contact information, like address, phone number, or email address
A government-issued ID number
Contact information, like address, phone number, or email address
A restricted, personal, medical document

You can now ask Google to remove your contact data from its search results.

WIPE YOUR FACEBOOK FOOTPRINT

Facebook stores a huge amount of information about you, from your phone number, location and marital status to your friends, interests and places you've been, as well as details of your activities on the social network. Visit the 'Your information' page (**www.snipca.com/42811**) to explore your full Facebook footprint.

Unlike Google, Facebook doesn't offer an easy way to erase your data, other than deleting your entire account. If that sounds too drastic, you can 'deactivate' your account, which retains your data but prevents other people from viewing it. Decide between deactivation and deletion at **www.snipca.com/42812**. If you choose the latter, Facebook gives you the option to download your Facebook information first (see screenshot above) or transfer it to another service.

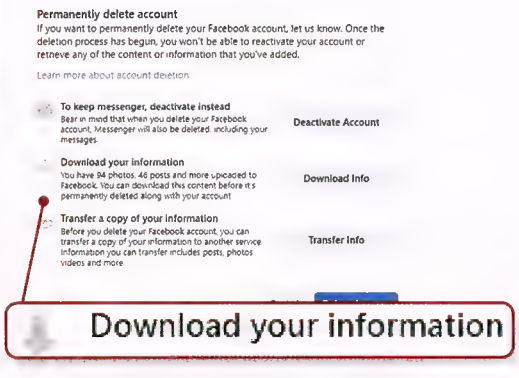
Alternatively, you can keep your Facebook account active, but remove specific content that compromises your privacy. Open your Facebook profile and click 'Activity log', then use the options on the left to review, edit and delete your posts, photos, interactions and other information.

"Previously, you could ask Google to remove certain information that could identify you, including bank account and credit card numbers, government ID data and explicit or defamatory content about you."

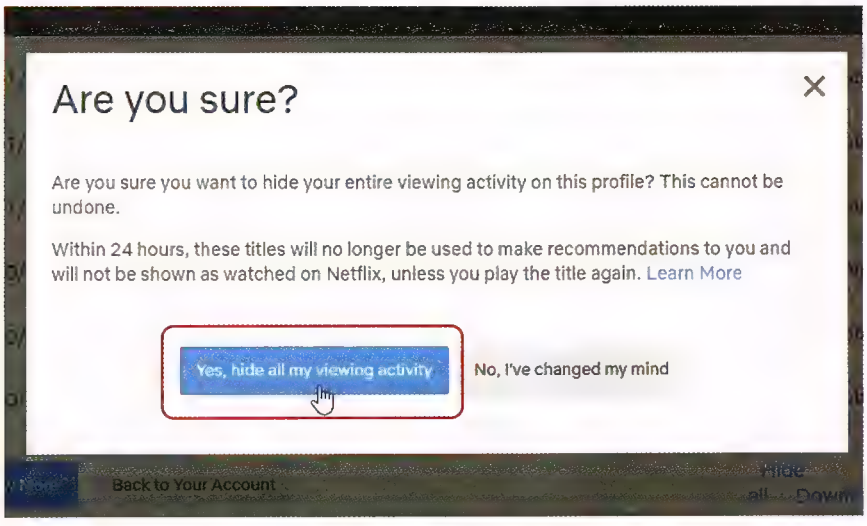
DELETE YOUR DATA FROM BING AND DUCKDUCKGO

Even if Google complies with your request to remove your personal data from its results, people may still be able to find it using Bing. Sadly, Microsoft's search engine doesn't have a removal-request procedure, so you'll need to ask website owners to delete the information. Use a site's 'Contact us' email address or form, or look up the domain name on Who.is (**https://who.is**) to get the details of the person who registered the URL.

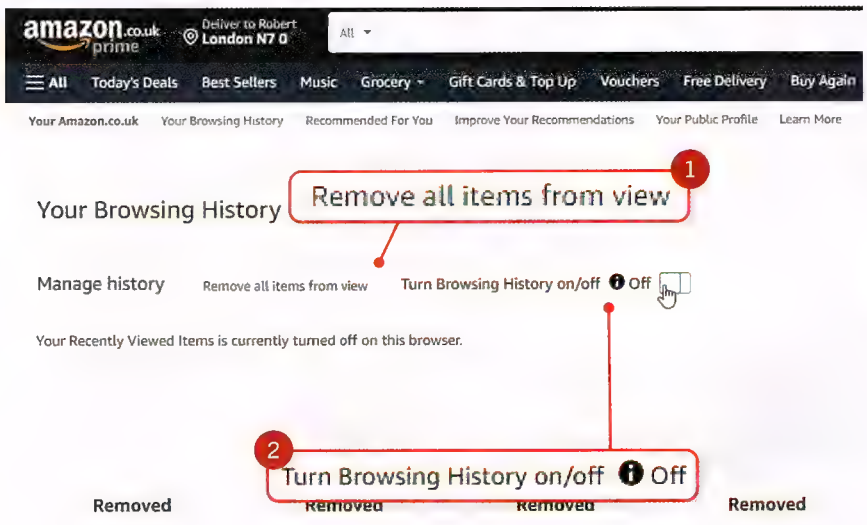
Once the webmaster has removed the offending content, it will eventually disappear from Bing, though this may take a few weeks. In theory, this should also remove your data from DuckDuckGo, which uses Bing for its search results. You can try speeding up the process by emailing **removalrequest@duckduckgo.com**.


Permanently delete account
If you want to permanently delete your Facebook account, let us know. Once the deletion process has begun, you won't be able to reactivate your account or retrieve any of the content or information that you've added.
Learn more about account deletion
To keep messenger, deactivate instead
Bear in mind that when you delete your Facebook account, Messenger will also be deleted, including your messages.
Deactivate Account
Download your information
You have 94 photos, 46 posts and more uploaded to Facebook. You can download this content before it's permanently deleted along with your account
Download Info
Transfer a copy of your information
Before you delete your Facebook account, you can transfer a copy of your information to another service. Information you can transfer includes posts, photos, videos and more.
Transfer Info
Download your information

Facebook lets you download your personal data before deleting your account.


Are you sure?
Are you sure you want to hide your entire viewing activity on this profile? This cannot be undone.
Within 24 hours, these titles will no longer be used to make recommendations to you and will not be shown as watched on Netflix, unless you play the title again. Learn More
Yes, hide all my viewing activity
No, I've changed my mind
Back to Your Account

Reduce your TV-streaming footprint by deleting viewing activity from Netflix


amazon.co.uk prime
Deliver to Robert London N7 0
All
All Today's Deals Best Sellers Music Grocery Gift Cards & Top Up Vouchers Free Delivery Buy Again
Your Amazon.co.uk Your Browsing History Recommended For You Improve Your Recommendations Your Public Profile Learn More
Your Browsing History
Remove all items from view
1
Manage history
Remove all items from view
Turn Browsing History on/off Off
Your Recently Viewed Items is currently turned off on this browser.
2
Turn Browsing History on/off Off
Removed
Removed
Removed
Removed

Remove items from your history to stop Amazon making recommendations.

To purge your Twitter feed of unwanted content, use TweetDelete (**www.snipca.com/42826**), which lets you erase any or all of your last 3,200 tweets and 'likes' for free. You can also use Redact (see page 66) to delete data from social networks.

DELETE YOUR SHOPPING DATA FROM AMAZON

Amazon doesn't just remember which products you've purchased from the store, but also everything you've searched for, and uses this information to recommend similar items. This compromises your privacy if you've been shopping for presents or personal items and Amazon displays related 'suggestions' on its homepage. What's more, adverts for products you've viewed can appear on other sites.

To stop Amazon using your history to make recommendations, go to your My Recently Viewed Items page (**www.snipca.com/42815**) and delete individual items by clicking the 'Remove from view' button under each one. Alternatively, click 'Manage history' and select 'Remove all items from view' (1 in screenshot above). Turn off Browsing History 2 to stop Amazon storing your activity in future, and opt out of 'interest-based ads' at **www.snipca.com/42820**.

You can't delete your Amazon order history, because it's a legal transaction record. However, you can conceal items you've bought so other people can't see them. Simply click the 'Archive order' button below each item on your Order History page (**www.snipca.com/42817**).

"Amazon doesn't just remember which products you've purchased from the store, but also everything you've searched for, and uses this information to recommend similar items."

WIPE YOUR NETFLIX VIEWING ACTIVITY

Netflix keeps a record of everything you've watched and when, so it can recommend TV programmes and films it thinks you'll like. That information is also available to anyone who accesses your account, whether they have your permission or not, at **www.snipca.com/42821**. We found that even after we cancelled our Netflix membership, we could still access our Activity page by Googling 'Netflix history' (presumably because the Netflix cookie was still in our browser).

You can remove specific entries from your Netflix viewing history by clicking the 'Hide from viewing history' icon next to each one. If it's a TV show, you also have the option to hide the entire series. To clear your history completely, select 'Hide all' at the bottom of the list and click 'Yes, hide all my viewing activity' (see screenshot above left). It can take up to 24 hours for removed titles to disappear from all your Netflix devices. Similarly, Prime Video lets you edit your 'watch history' at www.snipca.com/42823.

CAN YOU DELETE YOUR DATA FROM THE DARK WEB?

There are lots of tools that claim to monitor the dark web and alert you if someone is selling your personal data there – Norton 360, LastPass and NordVPN all offer this feature. In truth, these tools do little more than Have I Been Pwned and Firefox Monitor, and simply detect whether your email address has been involved in a data breach. Because the dark web isn't indexed by a search engine such as Google, and its marketplaces are often tightly secured to prevent DDoS attacks, it's very difficult to find out if and where your data is being traded by criminals. This makes deleting it nigh-on impossible. There's no honour among thieves, and dark websites are unlikely to remove information on request.

All you can do is keep an eye on your accounts and change your passwords if you suspect they've been compromised.

WIPE YOUR PERSONAL DATA FROM APPS

DELETE YOUR VOICE DATA FROM SMART ASSISTANTS

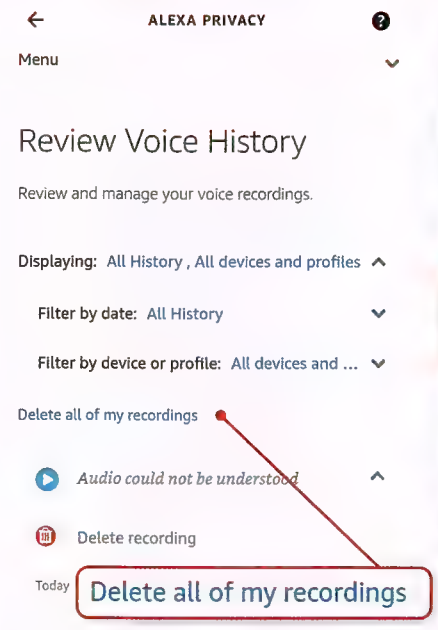
You don't need to own a Google Home or Nest smart speaker for your voice data to end up on Google's servers. Google Assistant is already installed on your Android phone or tablet and listening for you to say "OK Google" or "Hey Google". It may even have recorded your voice without your knowledge, though – to its credit – Google now requires you to opt in to audio storage (**www.snipca.com/42830**).

To review your Google Assistant activity, go to **www.snipca.com/42829** in your browser. You can either delete individual commands or click the arrow next to Delete and choose 'Delete all time'. Select 'Auto delete' to erase voice data automatically after three, 18 or 36 months. To switch off voice recording, select 'Saving to Web & App Activity' and untick 'Include voice and audio activity'.

Similarly, you can wipe voice data gathered by Amazon's Alexa smart assistant through its Echo smart speakers and Fire TV devices. In the Alexa app for Android or iOS, tap the More menu and choose Settings then Alexa Privacy. Press 'Review Voice History', select All History and choose 'Add devices and profiles' in the Displaying section. You can then either delete specific recordings or tap 'Delete all of my recordings' (see screenshot above right).

To stop Alexa saving your voice data, choose Manage Your Alexa Data on the Alexa Privacy Screen, tap 'Choose how long to save voice history' and select 'Don't save voice recordings'. Alternatively, you can delete recordings automatically after three or 18 months.

Apple makes it easy to delete your voice data from Siri. Simply open the Settings app on your iPhone or iPad, select 'Siri & Search' then 'Siri & Dictation History' and tap 'Delete Siri & Dictation History'.

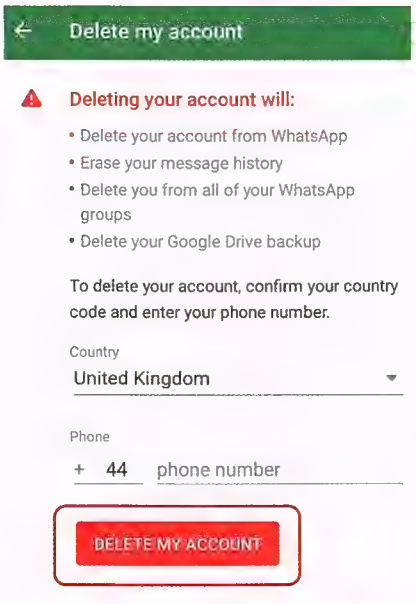

ALEXA PRIVACY
Menu
Review Voice History
Review and manage your voice recordings.
Displaying: All History , All devices and profiles
Filter by date: All History
Filter by device or profile: All devices and ...
Delete all of my recordings
Audio could not be understood
Delete recording
Today
Delete all of my recordings

You can delete voice recordings Alexa has captured through your Amazon devices.

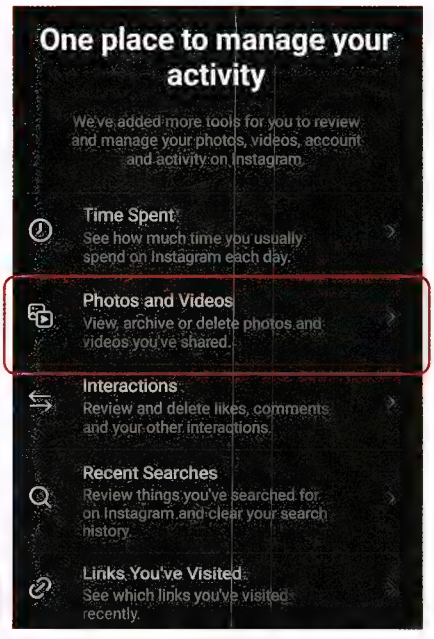
PERMANENTLY WIPE DATA FROM WHATSAPP

Unlike its Meta stablemate Facebook, WhatsApp is generally respectful of its users' privacy, offering end-to-end encryption of messages and calls, so that even the service itself can't read or listen to them. However, if you decide to ditch WhatsApp for another messaging app, you may want to delete your account for peace of mind. This was a big concern last year, when – due to a poorly worded change in privacy policy – many users believed WhatsApp was going to start sharing their data with Facebook.

Thankfully, wiping your WhatsApp account is actually very simple and will erase your entire message history, Google Drive backup and membership from groups. Open 'Settings' in the Android or iOS app, choose Account and tap 'Delete my account'. Confirm your phone number and press Delete My Account (see screenshot below).


Delete my account
Deleting your account will:
• Delete your account from WhatsApp
• Erase your message history
• Delete you from all of your WhatsApp groups
• Delete your Google Drive backup
To delete your account, confirm your country code and enter your phone number.
Country
United Kingdom
Phone
+ 44 phone number
DELETE MY ACCOUNT

Delete your WhatsApp account to permanently erase all messaging data.


One place to manage your activity
We've added more tools for you to review and manage your photos, videos, account and activity on Instagram.
Time Spent
See how much time you usually spend on Instagram each day.
Photos and Videos
View, archive or delete photos and videos you've shared.
Interactions
Review and delete likes, comments and your other interactions.
Recent Searches
Review things you've searched for on Instagram and clear your search history.
Links You've Visited
See which links you've visited recently.

Wipe your activity data from Instagram to protect your privacy from Meta.

DELETE YOUR INSTAGRAM DATA AND ACCOUNT

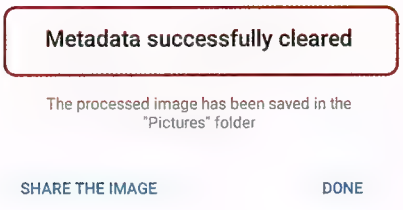
Instagram is probably the social app people are most likely to abandon after making a few posts – younger users have now moved on to TikTok while many older users have simply forgotten about it. This means any data you've shared remains in the clutches of Instagram's privacy-disregarding parent company, Meta.

To wipe your Instagram footprint, tap your profile picture in the bottom-right corner of the app, then the three-line menu in the top-right, and choose 'Your activity'. Tap 'Photos and Videos' (see screenshot above) to view content you've posted on Instagram, then tap Select, choose items to erase and press Delete. You can also delete your interactions (comments and likes), recent searches and links you've visited.

Instagram recently updated its iOS app to make it easier to delete your account and all the data in it. Choose 'Settings' in the three-line menu, then Account and tap 'Delete account'. Android users can only delete their accounts by visiting **www.snipca.com/42834** in a browser and providing a reason, such as 'Privacy concerns'.

REMOVE LOCATION DATA FROM PHOTO APPS

Your phone's camera automatically records the GPS coordinates of photos you take, so you can instantly see where you were. But when you share pictures online, this metadata poses a privacy risk because it could allow strangers to



Remove location metadata from your photos before sharing them online.

see where you live and where you've been. That's why it's a good idea to remove location data from certain images, in case they fall into the wrong hands.

You can do this in the Google Photos app by swiping up on a photo and tapping the Edit pencil icon next to the estimated location. Select 'Remove location' and it will delete the data. If Google Photos can't remove location data, use the free app Photo Metadata Remover (**www.snipca.com/42831**) to clear data from individual images or an entire folder of them at once (see screenshot above).

In the Apple Photos app on your iPhone or iPad, swipe up on a picture to open the Info panel, tap Adjust next to the location and select 'No location' to remove the GPS data.

CLEAN UP MULTIPLE SOCIAL ACCOUNTS IN ONE PLACE

A new free tool called Redact (**www.snipca.com/42837**) simplifies the process of reducing your digital footprint by deleting old content in bulk from social-media apps and websites, including Facebook, Flickr, Instagram, LinkedIn, Reddit and Twitter. Install it on your computer or Android device, select one of the listed services and log in - Redact claims it can't see your username, password or any other personal information. The Windows version saves you time by scanning your default browser to detect compatible accounts.

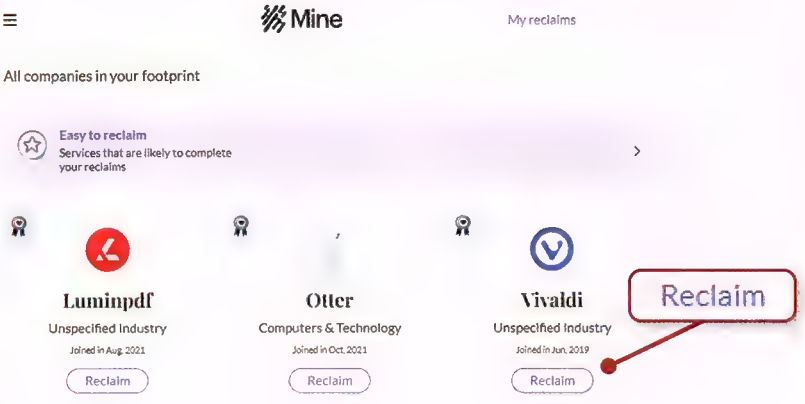
You can find posts you want to delete by selecting a date range and type of content, as well as attributes such as whether it contains a photo, video or specific keywords. Click or tap 'Select & Delete Mode', then Start Selecting to choose which data to remove – you can first use use Preview Mode so you don't accidentally delete something important. Finally, click or tap 'Delete [x] Items' (see screenshot left) to purge your account of the unwanted content.

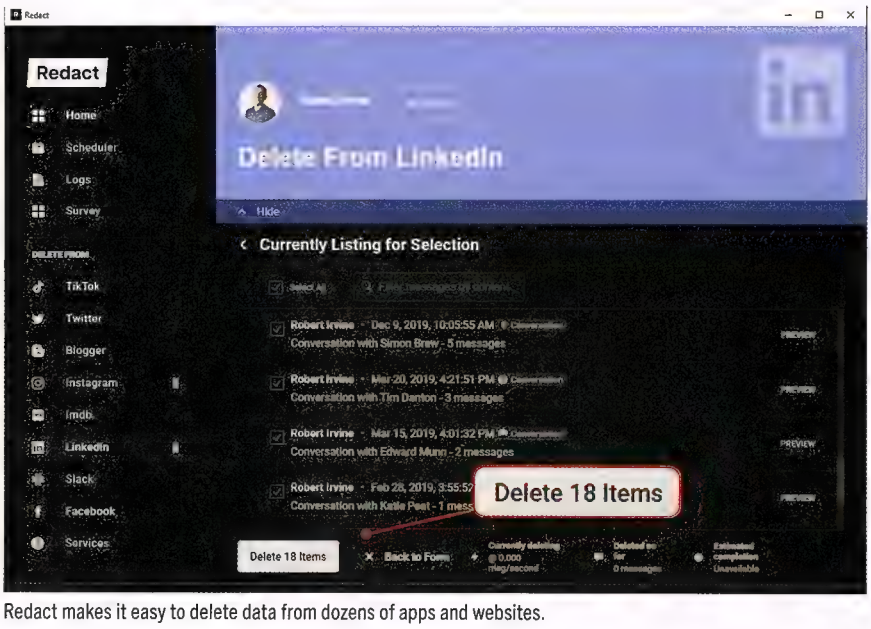
Redact is currently in beta so you may experience a few bugs, but it's already a useful footprint-wiping tool. An iOS version is coming soon, but note that Redact doesn't cover Google and Apple services, because it doesn't want to be banned from their respective app stores. ■

MANAGE YOUR DIGITAL FOOTPRINT USING MINE

One hurdle to wiping your digital footprint is that you may have forgotten which services you've signed up for over the years. A new service called Mine (**www.snipca.com/42840**) helps you remember by scanning your Gmail, Outlook or Yahoo inbox for evidence of site and app registrations and follow-up messages. It then tells you exactly which companies are holding your data, the type of information you've shared and the risk of your data being breached. If you see anything that concerns you, click Reclaim (see screenshot) and Mine will send that company a request to delete your personal data.

Mine itself may seem like a privacy risk, because you need to give it access to your email account. However, it explains on its Data Transparency page (**www.snipca.com/42841**) that no message data is processed or collected by its "non-intrusive AI". The service is currently free for personal use, but there are plans to introduce a premium plan in the near future.





Redact makes it easy to delete data from dozens of apps and websites.

The best as voted by Australians

Congratulations to the award-winning tech brands that took out honours in the 13th annual Mozo People's Choice Awards

TELEVISIONS
TCL, JVC, Hisense, Sony, Samsung

HEADPHONES
Bose, Apple, Jabra, Sennheiser, Anko, Sony, Samsung

SMARTPHONES
Apple, Google Pixel Oppo

mozo.com.au

mozo
The money saving zone

The quiet life

Fed up with spam, notifications and alerts? Nik Rawlinson goes in search of a more peaceful online experience.

The computer desktop has become a noisy place. For every hour we spend working productively, we spend another fighting spam, blocking pop-ups, silencing notifications and puzzling through overcomplicated cookie alerts.

It shouldn't be like that – and it doesn't need to be. The devices and programs you use every day, including your browser, your phone and even Windows itself, provide the tools you need to fight back. All you need to do is configure them. Here are some simple measures you can take to reduce the interruptions and regain your focus.

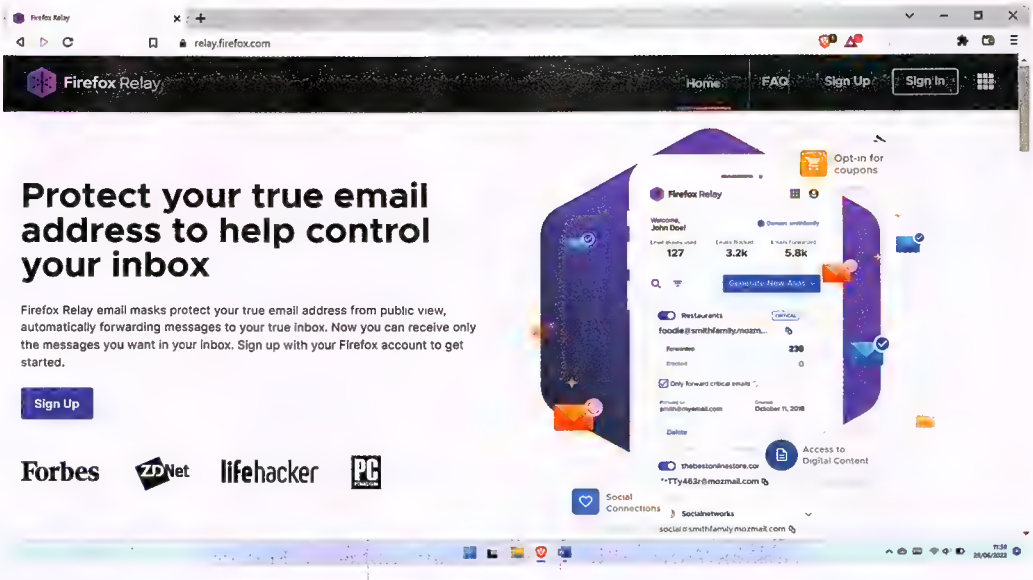
Email spam

Email spam is a fact of online life, and while you can reduce the volume you receive by being cautious about where you share your email address, it's impossible to stay spam-free. Web services such as Gmail and Outlook offer a few basic tools to tweak spam detection: you can nominate which addresses should never go to the spam folder, to cut down on false positives, and identify specific addresses that should always be blocked.

If you manage your own email address you have a lot more control. The open-source SpamAssassin tool from Apache (**spamassassin.apache.org**) is a popular option, and has been protecting inboxes for more than 20 years. It's usually enabled at the server level, so if you're using a hosted email service look for it in your provider's management interface. For example, if your provider uses Plesk, click Tools & Settings in the sidebar, followed by Spam Filter, and make sure "Switch on server-wide SpamAssassin spam filtering" is ticked.

SpamAssassin runs a series of objective and statistical tests on each message received to determine its overall spam quotient. If a message's final score exceeds a user-defined threshold, it can be deleted, quarantined or simply flagged with a warning in the subject line.

The usual advice is to start with a threshold of five, and to nudge this up if you end up with numerous false positives, or down if too much spam is slipping through. Finesse your approach slowly, with careful monitoring. If you're running SpamAssassin on your own server, you can improve results by using the command line tool sa-learn to scan your inbox and teach the system what good emails look like.


relay.firefox.com
Firefox Relay
Home
FAQ
Sign Up
Sign In
Protect your true email address to help control your inbox
Firefox Relay email masks protect your true email address from public view, automatically forwarding messages to your true inbox. Now you can receive only the messages you want in your inbox. Sign up with your Firefox account to get started.
Sign Up
Forbes
ZDNet
lifehacker
PC
Opt-in for coupons
Access to Digital Content
Social Connections

Firefox Relay conceals your personal email address.

Obscure your email address online

Publishing your email address on a website is a sure-fire way to attract spam, but sometimes it's the best way to let people reach you. If you need to put your address online, you can make it harder for website scrapers to harvest your email address by using CSS to obfuscate your address, like this:

```
<style>
  .rod::before {
    content: attr(jane) "\0040";
  }
  .rod::after {
    content: attr(freddy) ".com";
  }
  .rod .misdirection {
    display: none;
  }
</style>

<p class="rod" jane="name"
freddy="example"><span
class="misdirection">nobody sees
this bit</span></p>
```

The above code prints "name@example.com" in plain text on a web page, without that address appearing anywhere in the code. It works by storing the username and domain in separate variables; the address is assembled in the browser, by applying the ::before and ::after modifiers to a class called "rod", which contains nothing but a string of dummy text that is never actually displayed.

We've further muddied the water by calling our variables "jane" and "freddy", rather than identifiable names such as "username" and "domain", and we've steered clear of using "email" or "address" for the name of our paragraph style. While this approach may fox code scrapers, it's not perfect: the result is still rendered in plain text on the page, where it could be intercepted by screen scrapers. It might also make life more difficult for anyone who relies on a screen reader, too.

Use a disposable email address

If you prefer not to share your email address at all, a disposable address may be the answer. Services such as SharkLasers (**sharklasers.com**) assign you a random address that you can use for one-off sign-ups; once you've picked up your verification email at the main website, you can forget about the address entirely.

> "Email spam is a fact of online life. If you manage your own email address you have a lot more control"

Be aware, though, that these disposable mailboxes aren't password-protected. Anyone can browse incoming messages, so don't use them for financial matters or password reminders.

For such purposes, consider an email relay service instead. Firefox Relay (**relay.firefox.com**) assigns you a disposable email address that you can give out freely and use for as long as you like. Incoming messages are securely forwarded to your genuine inbox, and when your temporary address starts to attract spam, you can simply shut it down and create another.

The free service allows you to create up to five addresses, using either a browser extension or the Firefox Relay dashboard. There's also a paid-for tier, costing 99c a month: this gives you your own catch-all subdomain, within which you can use a unique address for each service you sign

up to. For example, if you selected "apc" as your subdomain, you could enter your address at various websites as woolworths@apc.mozmail.com, debenhams@apc.mozmail.com, ourprice@apc.mozmail.com and so forth – and if one address becomes spammy, you can shut it down without disturbing the rest.

Silence desktop notifications

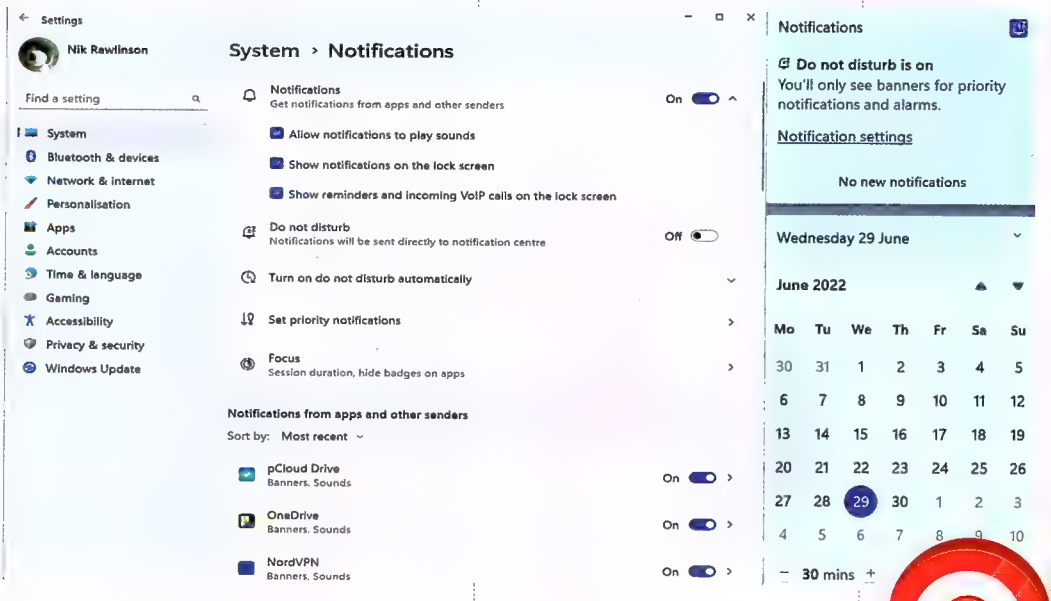
Windows 10 pops up a fairly regular procession of notifications in the Action Center. To tailor what appears here, press Windows-I to open the Settings app, click System, followed by Notifications & actions. Here you'll find a master switch labelled "Get notifications from apps and other senders"; turn it off to silence many of those unwanted alerts.

Turning this off doesn't mean you'll never see another pop-up, however. It only disables notifications from apps, notification sounds, and alerts on the lock screen. Windows will still highlight new features and pop up suggestions as to how you might get more out of the operating system. To silence these notifications too, clear the three tickboxes beneath the switch. If you only want to mute the odd overbearing application, scroll down to "Get notifications from these apps", and you can disable and enable them individually.

Perhaps you only want to disable notifications at specific times, such as outside working hours, or when you're playing games or watching videos. For this you can turn to the Focus Assist feature. Again, this is found in the Settings sidebar, and it lets you block notifications in each of the above scenarios, or according to your preferred schedule. You can also turn Focus Assist on and off as needed by clicking on its tile in the Action Center. If you can't see it, open the Action Center by clicking the taskbar speech bubble, then either click Expand or right-click the speech bubble. Hover over "Focus assist" and select "Priority only" or "Alarms only".

In Windows 11, things are a little simpler. You can simply right-click the clock and select "Notification settings"; from here you can switch off notifications as a whole, or turn on "Do not disturb", which sends notifications straight to the notification centre without alerting you. You can also enable this option from the notification centre itself by clicking the bell overlaid by "Zz".

As on Windows 10, you can set Do Not Disturb mode to automatically kick in according to your preferred schedule, or when you're playing games, duplicating your display or using an app in full-screen mode. Scroll further down the dialog for more granular control.



Below left: Notifications can be tailored in Windows 11's Settings app. **Below:** You can turn on Do Not Disturb from the notification centre.

> "You can set Do Not Disturb mode to automatically kick in according to your preferred schedule."

Taming Linux notifications

In Ubuntu 22.04 and later, a Do Not Disturb switch is built into the message tray, which drops down from the top bar when you click the clock. For earlier versions – and any other Gnome-based Linux distribution that doesn't have a native Do Not Disturb function – you can use the Do Not Disturb Button extension (**tinyurl.com/APC512DND**).

Gnome's Settings app gives granular control over mass alerts, plus app-by-app settings. Clicking Notifications in the sidebar provides another route to the Do Not Disturb switch, along with a second switch to turn lock-screen notifications on and off. Click an app title to open a dialog box giving control over notifications in general, as well as options for sound alerts and whether to show content previews in pop-ups.

Mac notifications

In macOS, clicking the clock opens both notifications and widgets; hold down Alt while clicking to turn on Do Not Disturb mode. Once you've done this, a moon icon appears next to the menu bar, which you can click to choose how long Do Not Disturb mode stays enabled. By default it remains on until you manually turn it off, but you'll see one-click options to enable it for an hour or until the evening.

For greater control over your alerts, open System Preferences and click Notifications. Here, you can schedule Do Not Disturb to apply between specific hours, when the display is sleeping, when the screen is locked, or when mirroring.

You can also choose whether to receive calls from everyone, or only repeated calls when Do Not Disturb is active.

The sidebar offers controls for individual apps; for each one you can turn off notifications entirely, or suppress them on the lock screen.

You can also choose whether each app should use banners that automatically vanish after a few seconds or traditional alerts that remain visible until you manually close them.

Silence your phone

The easiest way to silence your phone is to, well, stick it in silent mode – or ideally, turn it off. If that isn't practical, there are others ways to reduce interruptions when you have more important things to think about. Not all of these tips will apply to every phone, but see which works for you.

1 TURN IT UPSIDE DOWN

Many smartphones can detect when they've been placed face down, and activate quiet mode automatically. To enable this feature on a Pixel phone, open Settings and tap System, followed by Gestures. Scroll to the bottom of the list and tap "Flip to Shhh". On the following screen, turn on the switch beside "Use flip to Shhh".

2 DO NOT DISTURB

If putting your phone face down doesn't suppress notifications, you can enable it manually. On stock Android, slide down from the top of the screen and tap Do Not Disturb; on an iPhone X or later, slide down from the top right to open the Control Centre. Tap the Focus button, then tap Do Not Disturb.

iOS also offers various Focus options, including for sleep and driving, and you can add new profiles by tapping New Focus at the bottom of the screen. You can tweak what each of the Focus presets allows through or blocks, including whose calls are allowed through and which apps are permitted to pop up notifications.

3 SCHEDULE DOWNTIME

iOS Focus modes can be set to turn on automatically by tapping "Add Schedule or Automation" at the bottom of each mode's settings pane. From here, you can create a schedule, set a Focus mode to activate when you arrive at a particular location, or enable it when using specified apps.

To schedule some silence on Android, swipe down from the top of the screen and long-press on Do Not Disturb to open its settings. Tap Schedules followed by "Add more", then Time. Depending on your phone, you may also be able to set up other automated triggers: for example, Samsung phones support Bixby Routines, which let you enable and disable Do Not Disturb in response to a wide range of conditions.

Block website notifications

It's becoming increasingly common for websites to ask permission to send you notifications. This itself is an annoying intrusion, and if you agree then sites can pop up distracting alerts in your browser even when you're not browsing that site.

On a Chromium-based browser such as Chrome or Microsoft Edge, there's a simple way to block all notifications and requests. Just type **chrome://settings/content/notifications/** into the address bar, press Return, then click the radio button labelled "Don't allow sites to send notifications".

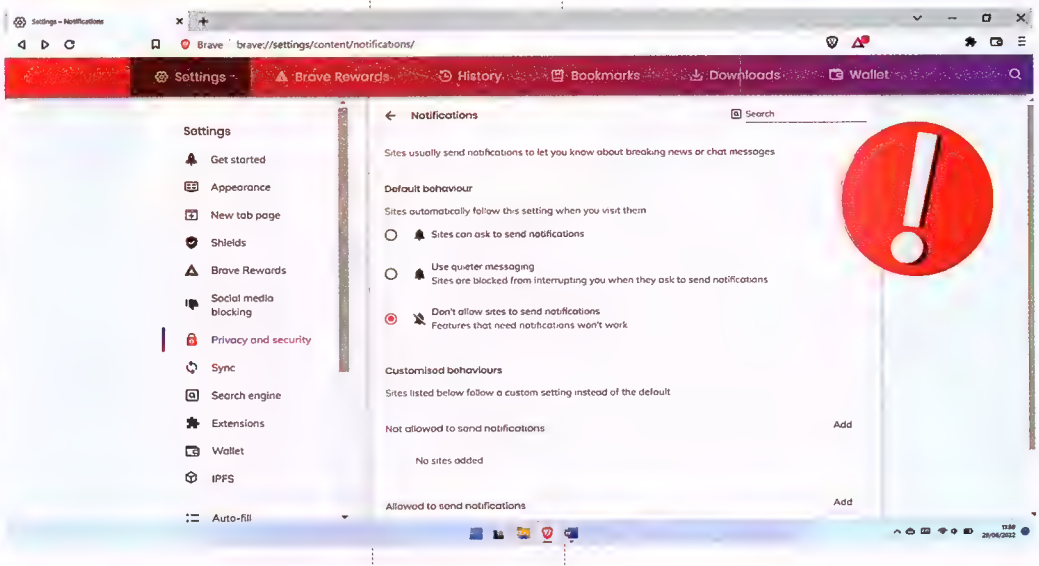
As the page warns, web apps that rely on notifications may not work properly if you disable them. You might therefore want to add selected sites, such as Google Docs, to a list of exceptions. Click Add beside "Allowed to send notifications" and type the domain (or subdomain if you prefer not to enable the whole domain) into the Site box, then click Add.

Alternatively, you can select "quiet messaging": with this option active, pop-up notifications and requests will be blocked by default, but an unobtrusive notification will be shown in the address bar that you can click to change settings for that site.

If you use Firefox, use the browser to visit about:preferences#privacy, scroll down to the Permissions section and click the Settings... button to the right of Notifications. On the page that opens, tick the box beside "Block new requests asking to allow notifications", and click Save Changes.

Flip to Shhh
Use flip to Shhh
To turn on Do Not Disturb, place your phone face down on a flat surface. You'll feel a subtle vibration when Do Not Disturb turns on.

Left: Some phones can be silenced by turning them face down.



Above: You can stop notification requests in your browser settings.

Opt out of cookies

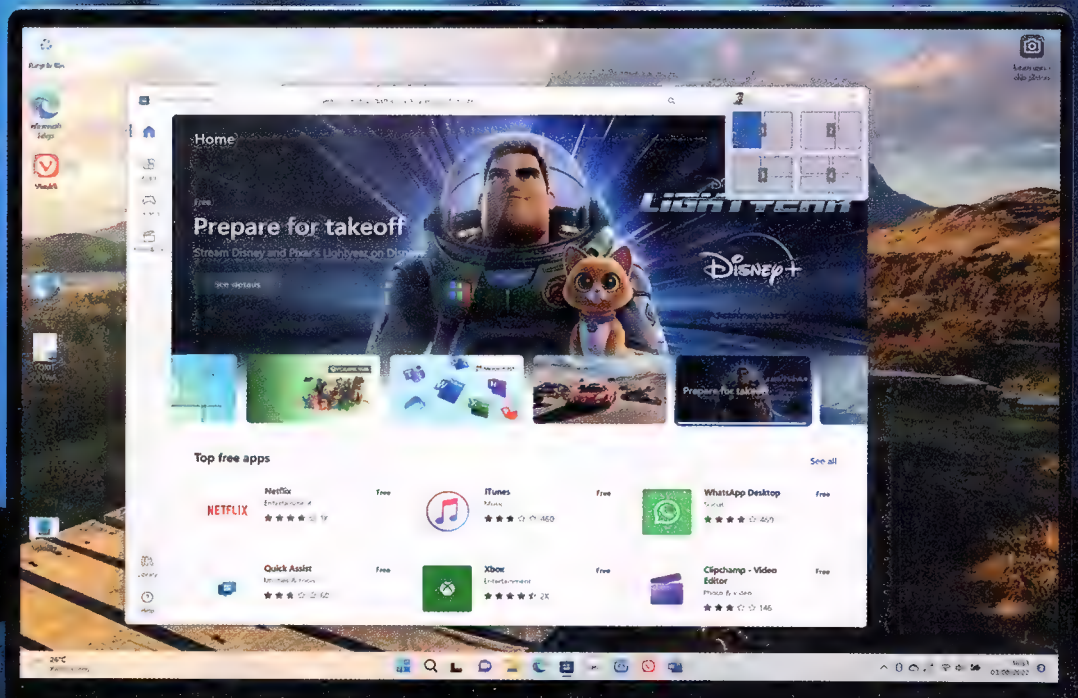
Cookie consent pop-ups are some of the most annoying interruptions on the web. In theory, they're supposed to put you in control of your own data; however, researchers in 2020 found that, across the top 10,000 websites, fewer than 12 percent of the cookie pop-ups met minimal requirements. The remainder used "dark patterns" to push visitors towards giving up their privacy, or they didn't ask at all (**tinyurl.com/APC512DARK**).

As with web notifications, you can save some hassle by using technical measures to automatically reject all optional cookie requests. Although this option isn't built into most browsers, you can achieve it with the Consent-O-Matic extension, developed by Denmark's Aarhus University. It's available for Chromium-based browsers (**tinyurl.com/APC512CHR**), Firefox (**tinyurl.com/APC512CHRFF**) and Safari (**tinyurl.com/APC512SAF**).

If you do want to accept some optional cookies, the settings allow you to enable any of six cookie types, including information storage, ad delivery, preferences and functionality. The extension works with most websites, drawing on a database that's updated every 15 minutes. ■

WINDOWS 11 WHAT'S COMING NEXT

Windows 11 is getting its first major update this spring. Barry Collins runs through all the new features to look for.



When Microsoft first launched Windows 11 a year ago, it said it would only launch one major update for the operating system every year instead of two. Well, a year on, it's time for Windows 11's first major makeover – and it doesn't disappoint.

There's no single new feature in Windows 11 that's going to blow your mind or make any of the Windows 10 holdouts suffer enormous pangs of regret. However, there are plenty of worthwhile tweaks and new features that make Windows 11 feel much more like a grown-up OS and less like Windows 10 with a new shopfront.

The update, named 22H2 to signify that it will be released in the second half of 2022, covers a lot of ground. There are major updates to Windows 11's accessibility features, significant changes to the way Windows Explorer works, new features designed specifically for developers, and concerted attempts to make our PCs consume less energy – something that many will welcome amidst the current energy crisis. As sure as night follows day, Microsoft has also tweaked the Start menu. Again.

We've put the latest beta build of Windows 11 22H2 through its paces, testing the phalanx of new features and changes to the OS that have been made at the time of writing. It's possible Microsoft may squeeze in a few more amendments before the final release, which is expected in late September or early October, so be on guard for any late additions or omissions.

Windows 11 isn't the only Microsoft operating system to be getting an autumn refresh, either. Check what's coming to Windows 10 on p79 to discover what you can expect for the legacy OS.

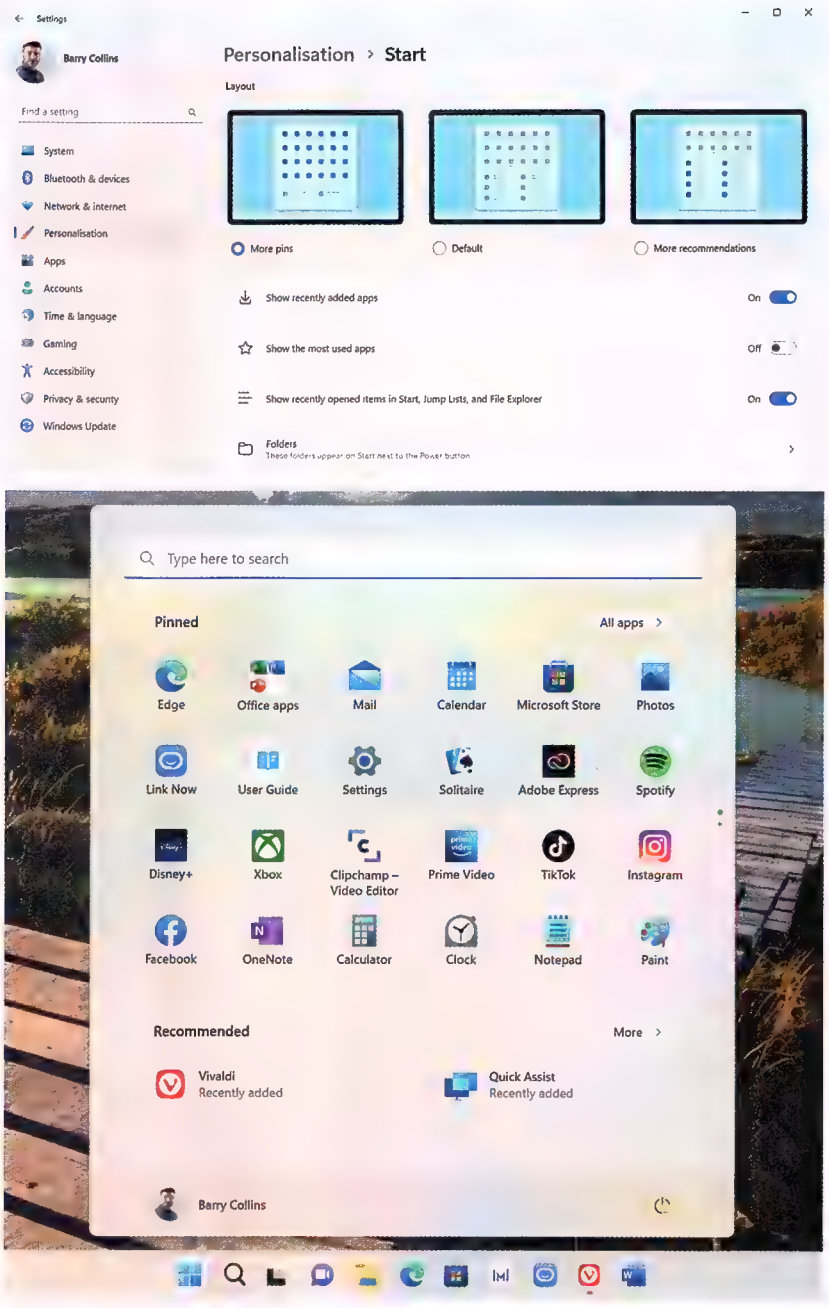
HOW TO GET THE 22H2 UPDATE TODAY

The 22H2 update will soon start rolling out to the general public, but to get it early head to Windows Update and sign up to be a Windows Insider. When prompted to choose your Insider channel, select "Release Preview" and then follow the prompts.

When you restart your PC, Windows should automatically install the latest preview build – at the time of writing, the Windows 11 22H2 update. To check it's happening, head to Windows Update once again, where you should see "Windows 11, version 22H2, is available". If it isn't there, click "Check for updates". You may need to wait a few minutes.

We probably don't need to say this, but we will anyway: while the Release Preview is known to be stable, it still comes with risks. Back up your data, don't load it onto your one and only machine, and most of all don't blame us if it goes wrong!

Prefer to download an ISO file? Our sister site tomsguide.com has a tutorial that steps you through that process, which you can follow by heading to tinyurl.com/APC512ISO.



Top: The Start menu has been tweaked once again – but this time for the better.
Above: More pins devotes more space to the stuff you actually want on the Start menu.

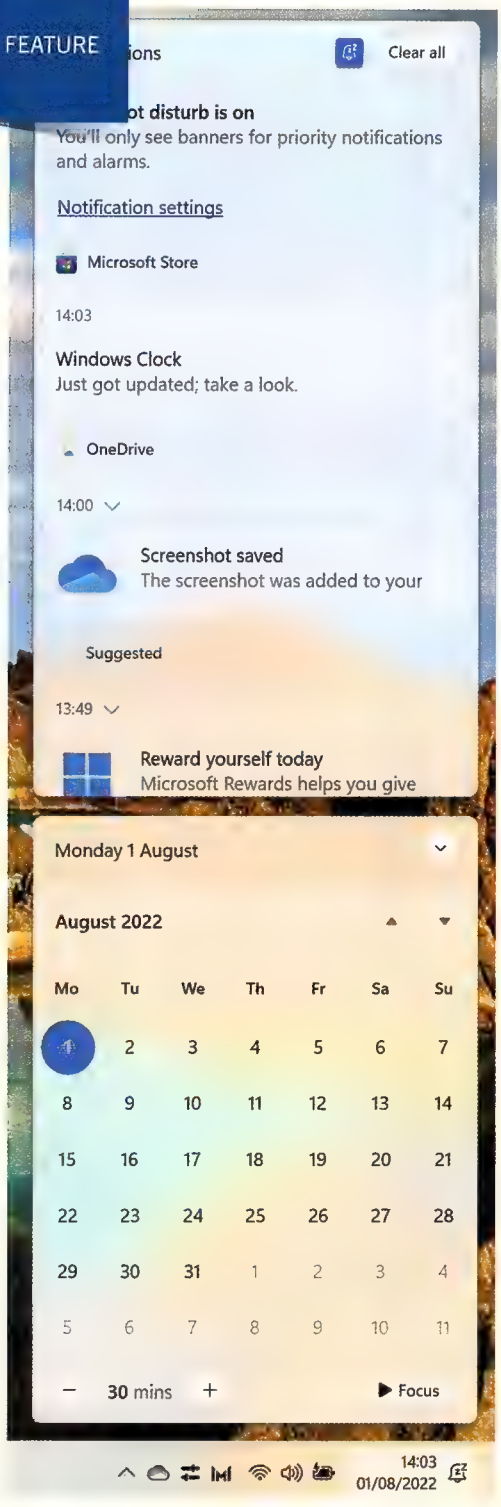
Another new Start!

It simply wouldn't be a Windows update without some fiddling around with the Start menu. Microsoft just can't leave it alone. However, don't despair. The changes made to the Start menu are all for the better, in our opinion.

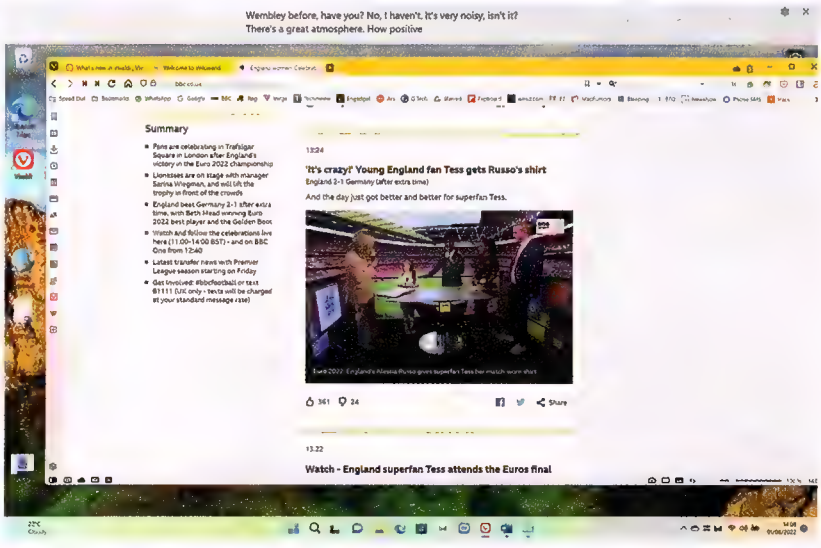
The first version of Windows 11 saw the introduction of Recommended in the Start menu, a faintly useless feature where Microsoft was too clever for its own good and attempted to thrust newly installed apps or regularly accessed documents in your face. The suspicion was that Microsoft would eventually start using the space as advertising inventory.

Microsoft isn't quite prepared to admit it was a daft idea just yet, but there are clear signs of a reverse ferret. The Start menu settings (Settings | Personalisation | Start) now provide three options: "More pins", default (as you were) and "More recommendations" (for the clinically insane). More pins devotes more space to the stuff you actually want on the Start menu, while leaving only a couple of lonely Recommendations clinging to the foot of the menu.

You might want more space for those pinned apps, because Microsoft has revived another useful new feature in this space: folders. You can now drag pinned apps over one another to create Start menu folders, in a similar vein to Android, iOS and indeed Windows 10's live tiles. Folders can be renamed with a right-click on their name, allowing you to put all the Office apps in the space of one icon,



Above: The Don Not Disturb feature can be turned on in the Notification Centre.


Wembley before, have you? No, I haven't. It's very noisy, isn't it?
There's a great atmosphere. How positive
Summary
'It's crazy!' Young England fan Tess gets Russo's shirt
Watch - England superfan Tess attends the Euros final

Above: Live Captions provide a real-time transcription of any spoken audio playing on your PC.

DO NOT DISTURB AND FOCUS

No other company ties itself in as many branding knots as Microsoft. Exhibit 3,564A: the new Do Not Disturb and Focus sessions.

What was known as Focus Assist is now being renamed Do Not Disturb. This can be turned on from the top of the Notification Centre and works pretty much as before. All notifications will be shunted directly to the Notification Centre without bleeps, blangs or pop-ups, except for those assigned as priority notifications. You can adjust these in Settings.

Then we come to Focus sessions. These can be started by clicking the clock in the bottom-right corner of the screen and pressing the Focus button. By default, they are set for half an hour and are designed to let you concentrate on a specific task (such as writing a feature about Windows 11's new features) without distractions. A Focus session turns Do Not Disturb on, and it also disables notification badges on Taskbar shortcuts and notification flashing on Taskbar shortcuts.

A little clock icon appears on the desktop, showing how much of the Focus session remains. You can press the stop button on the clock if you get the job done early and want to dive back into your social media flame wars.

for example. Seasoned Windows users might, of course, prefer to open apps via the keyboard, and should you be among them then we highly recommend installing the free PowerToys Run (**docs.microsoft.com/en-us/windows/powertoys/**), which is a blatant rip-off of macOS's superb Spotlight search. Why this isn't built into Window 11 is a mystery worthy of Columbo.

Right-clicking on the Start menu – also activated with Windows-X – presents a couple of new things worth noting. "Apps and Features" is now called Installed Apps, which is pretty much the same thing, but still provides a quick shortcut to getting shot of unwanted apps. Windows Terminal is now the default command line app.

Supercharged accessibility

As Jon Honeyball wrote in a recent column (see issue 509, p18), an accessible OS isn't just a box-ticking exercise, it makes a better operating system for everyone. The new accessibility options in 22H2 are evidence of that.

Let's start with Live Captions, which are now built into the OS – just search for the app from the Start menu. Live Captions provide a live transcription of any spoken audio playing on your PC. That might be a Teams meeting, a YouTube video or a podcast. Even if you're lucky enough to enjoy perfect hearing, Live Captions could be a huge help in environments where you can't listen to audio (train carriages, say) and you don't have headphones with you. Or if you're trying to juggle multiple calls simultaneously.

By default, the transcription appears at the top of the screen, and in our tests it was pretty accurate. That's even more impressive, given the audio is being transcribed locally, not in the cloud, which means the Live Captions can be used even when you're offline. Bear in mind, however, that Windows needs to download a language pack the first time you use Live Captions, and that it's currently in US English only.

Voice Access is even more impressive. This newcomer enables you to control the entire operating system by voice, and it's remarkably easy to get to grips with. Aside from opening and closing apps by name, being able to click on specific buttons (by saying "click Submit", for example) and speaking text into Word and other apps is phenomenal. You may be reading this with a cynical frown, but trust us: the manner in which it lets you do stuff that would seemingly be impossible by voice is a triumph.

For example, you can tell Windows to put a grid over the screen, with each square given a number between 1 and 9. Each square within that grid can then be broken down into a smaller grid, until you reach the point where

the targeted icon is the only one in that grid square and you tell Windows to click that square's number.

Alternatively, you can tell Windows to "Show numbers" and it tries to attach a number to any clickable item on screen, be that an icon, a web link or an app in the Taskbar. It's a long way from perfect, and it works better with Microsoft's own browser and apps than it does with third-party ones, but it's truly possible to get stuff done with voice alone.

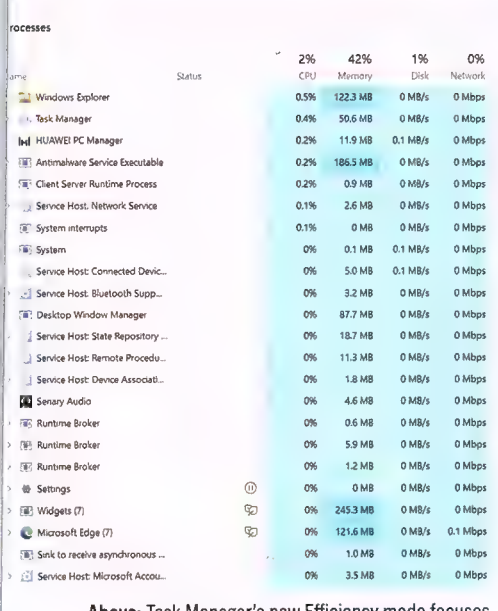
Finally on the accessibility front, Microsoft continues to make improvements to Narrator, which reads what's happening on the screen for the visually impaired. There's a new selection of "natural" voices to choose from, although again these are currently restricted to voices with a US accent. Microsoft also claims to have improved the scan mode navigation, so that items on the page are less likely to be read out time and again.

Revamped Task Manager with Efficiency mode

Task Manager has been given a new look for 22H2. The most obvious visual change is that the tabs that let you access Processes, Performance monitor, App history and so on have been moved to the left of the window, instead of running along the top.

The bigger deal, however, is the advent of Efficiency mode, which is part of the operating system's wider focus on reducing energy consumption. It's the successor to the Eco mode that was previously available, but works differently.

Efficiency mode limits the CPU resources available to selected processes, ensuring they don't get in the way of the


rocesses
2%
CPU
42%
Memory
1%
Disk
0%
Network
Status
Windows Explorer 0.5% 122.3 MB 0 MB/s 0 Mbps
Task Manager 0.4% 50.6 MB 0 MB/s 0 Mbps
HUAWEI PC Manager 0.2% 11.9 MB 0.1 MB/s 0 Mbps
Antimalware Service Executable 0.2% 186.5 MB 0 MB/s 0 Mbps
Client Server Runtime Process 0.2% 0.9 MB 0 MB/s 0 Mbps
Service Host: Network Service 0.1% 2.6 MB 0 MB/s 0 Mbps
System interrupts 0.1% 0 MB 0 MB/s 0 Mbps
System 0% 0.1 MB 0.1 MB/s 0 Mbps
Service Host: Connected Devic... 0% 5.0 MB 0.1 MB/s 0 Mbps
Service Host: Bluetooth Supp... 0% 3.2 MB 0 MB/s 0 Mbps
Desktop Window Manager 0% 87.7 MB 0 MB/s 0 Mbps
Service Host: State Repository ... 0% 18.7 MB 0 MB/s 0 Mbps
Service Host: Remote Procedu... 0% 11.3 MB 0 MB/s 0 Mbps
Service Host: Device Associati... 0% 1.8 MB 0 MB/s 0 Mbps
Senary Audio 0% 4.6 MB 0 MB/s 0 Mbps
Runtime Broker 0% 0.6 MB 0 MB/s 0 Mbps
Runtime Broker 0% 5.9 MB 0 MB/s 0 Mbps
Runtime Broker 0% 1.2 MB 0 MB/s 0 Mbps
Settings 0% 0 MB 0 MB/s 0 Mbps
Widgets (7) 0% 245.3 MB 0 MB/s 0 Mbps
Microsoft Edge (7) 0% 121.6 MB 0 MB/s 0.1 Mbps
Sink to receive asynchronous ... 0% 1.0 MB 0 MB/s 0 Mbps
Service Host: Microsoft Accou... 0% 3.5 MB 0 MB/s 0 Mbps

Above: Task Manager's new Efficiency mode focuses on reducing energy consumption.

TASKBAR TWEAKS

The Taskbar gets a couple of minor alterations in this release. The first is the return of the Taskbar overflow. If you manage to open more apps than there's space for on the Taskbar – and that was quite a challenge in our tests – then an overflow section is created, where you can access icons that are hidden from the main view.

Microsoft is also making a fresh attempt to make Widgets relevant, by putting so-called Dynamic Widgets on the far left of the Taskbar, where the Start button used to reside. In our test of the beta OS, that comprised nothing more than a weather forecast widget, which is barely eyebrow raising. As we've said before, if Microsoft opens up Widgets to third parties, the entire concept could be transformed. It may happen before we're all pushing up daisies, but don't bet your funeral fund on it.

TEAMS ON THE TASKBAR

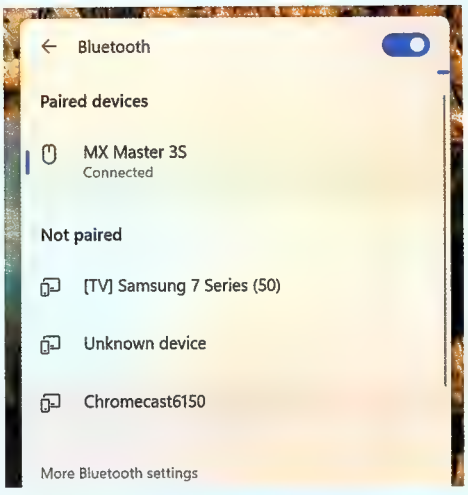
Microsoft is finding yet more cunning ways to ensure you don't neglect Teams for your business meetings, with two new Taskbar-related features.

The first is the option to easily share an open window with a colleague when you're on a Teams call. When you hover over an app's icon on the Taskbar, just below the app preview thumbnail a button to "Share this window" in Teams should appear. It didn't in our tests with the beta OS, but it may be a work in progress.

Microsoft is also making it a tad simpler to mute yourself on Teams calls. As soon as you start a call, the mic icon appears in the System Tray, making it easy to mute yourself even if Teams isn't the active window. You are paying attention on your Teams calls, aren't you?

NEW "OPEN WITH" DIALOG

File this one under "ah-ha", but the Open With dialog has been given a revamp,



Above: Bluetooth settings have been added to the Quick Settings menu.

making it slightly easier to choose alternative apps to open a certain type of file.

Of course, Microsoft is trying the gentle nudge towards its own apps, but it's interesting to see a third-party app (the Vivaldi web browser) as a "suggested" app on this list. Although also presenting Media Player as an option for PDFs is one for the bug reports.

The dialog now makes it easier to set a default app for such files, to save you having to go through the fandango again.

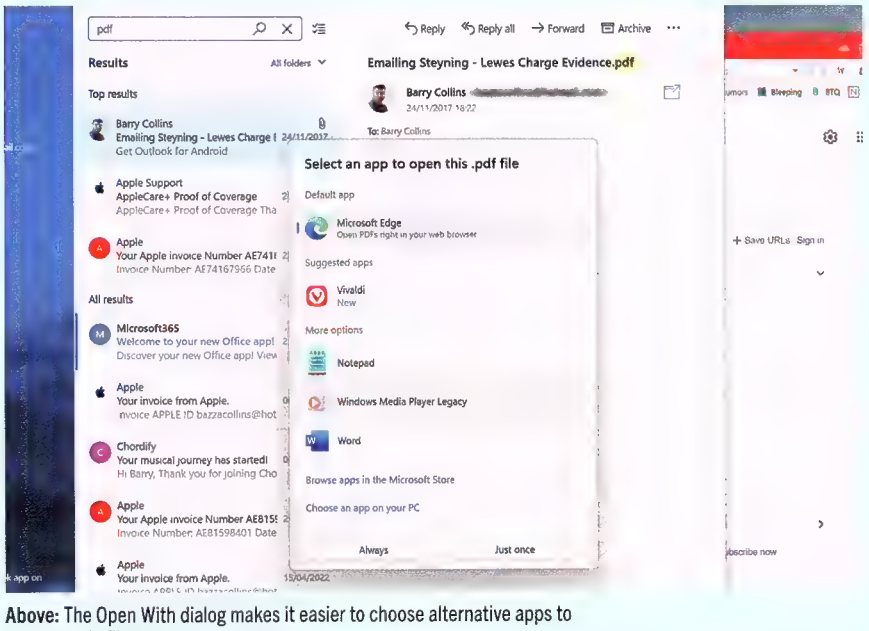
ACCESSIBLE BLUETOOTH SETTINGS

Bluetooth headphones are now pretty much the default option, not to mention all the other Bluetooth devices we connect to our PCs. So it makes no sense to hide the Bluetooth settings away.

Version 22H2 sees Bluetooth settings added to the Quick Settings menu, which is opened by clicking on the icons directly to the left of the clock. Here you can select or add Bluetooth devices without having to dive into the Settings app. A small but considerate time saving.

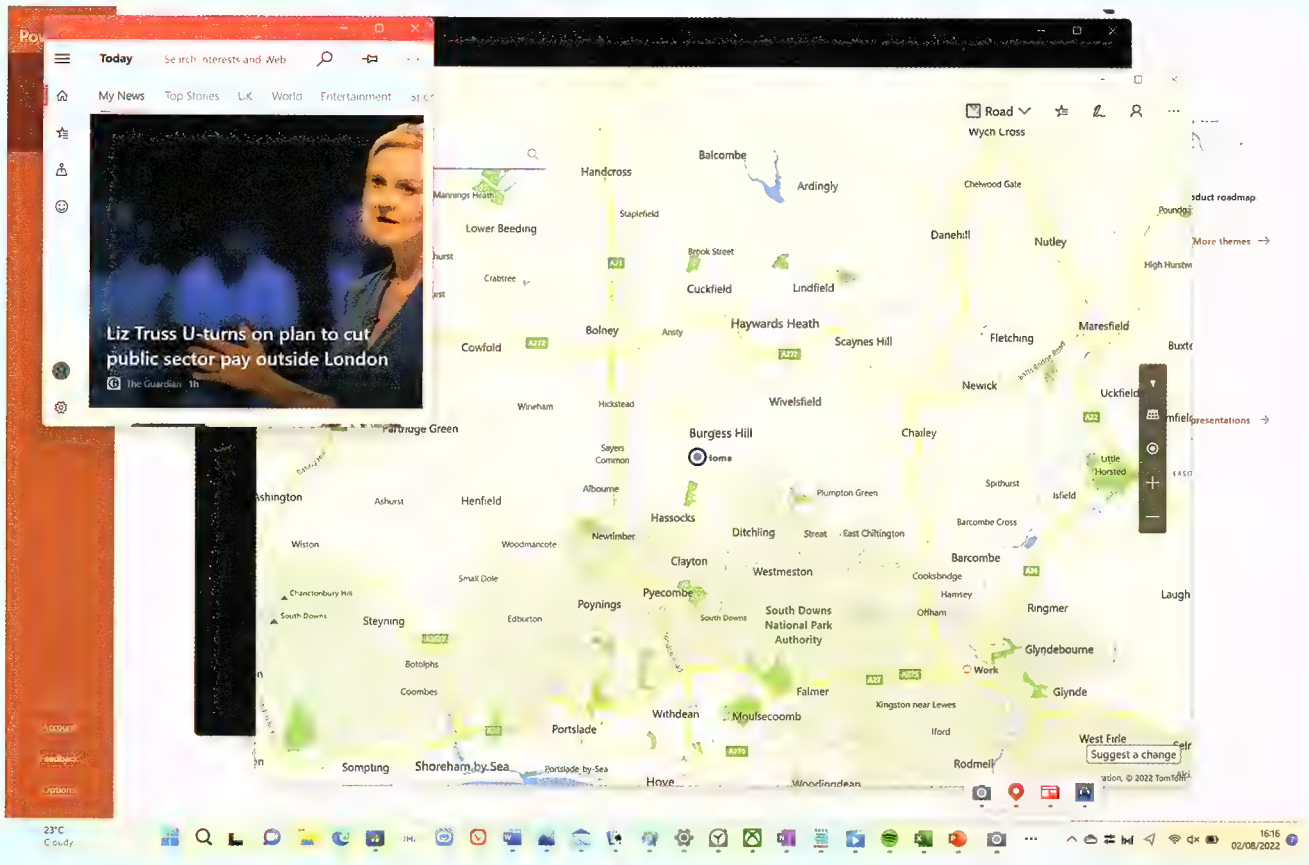
TABS AND MORE IN FILE EXPLORER

It's a close-run thing between the Start menu and File Explorer for most fiddled with part of the Windows furniture in recent years. Continued next page...



Above: The Open With dialog makes it easier to choose alternative apps to open certain file types.

TASKBAR TWEAKS CONTINUED



Above: It takes a huge amount of effort to open more apps than there's space for on the updated Taskbar, but do so and you'll see an overflow section.

This update certainly gives File Explorer a proper makeover.

The most obvious change is the introduction of tabs. Like a browser window, you can now have different File Explorer tabs open simultaneously, making it easier to navigate between different parts of your system without opening multiple windows. You can still right-click to open in a new File Explorer window, which might make dragging-and-dropping exercises easier.

That said, moving files between tabs is simple. Select the file/folder, drag it to the tab you want to copy it to, and the focus will switch to that tab, where you can drop it. It's neatly implemented.

If you've got a file that you make constant reference to, that can now be pinned to Favourites in File Explorer, so it always appears front and centre when you open an Explorer window. That's distinct from the Quick Access folders in the Explorer sidebar, which remain in place.

Thumbnails are also back for File Explorer folders, giving you a little peek at the contents you can expect to find in that folder.

Finally, Microsoft has improved OneDrive integration in File Explorer. A little OneDrive icon sits on the right of the window, and you can click that to get an instant glance at your sync status and how much of your personal storage allowance remains. We hope Microsoft doesn't use this as an upsell opportunity when you're creeping close to your OneDrive storage limit; then again, we hope to sell a million copies of *APC* next month...

COPY PATH TO SELECTED FILE

A small tip for power users – File Explorer includes a new feature that allows you to copy the file path to a selected file or folder. Select the file/folder and then press Ctrl-Shift-C to copy its file path.

BETTER SNAP LAYOUTS

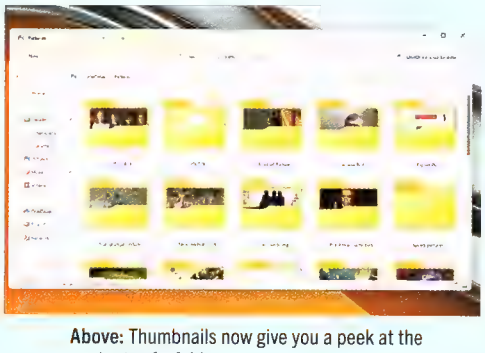
If there's one area where Windows 11 is streets ahead of macOS, it's Snap Layouts. The ease with which you can "snap" windows to certain parts of the screen shames Apple, which needs third-party plugins to achieve the same effect.

Snap Layouts are even better in 22H2. Now you can pick up a window and drag it to the top of the screen, where you'll be given the option to snap that window into one of the preset layouts. It's far, far easier than the previous method of using the full-screen icon.

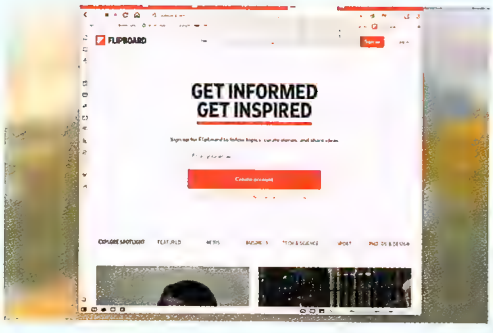
There's another new keyboard shortcut method to access those Snap Layouts, too. Press Windows-Z and a pop-up will appear in the top right of the window, with each of the different layouts numbered. You choose your chosen layout by pressing the relevant number and then select the position of the window with the arrow keys. That sounds more complicated than it is in actual use. Trust us, it works brilliantly.

SCROLL THE NEW VOLUME SLIDER

The Windows 11 volume controls have a new look, with the volume slider now appearing just above the Taskbar. Not a big deal, and neither is the ability to control the volume by scrolling your mouse wheel over it, but both are delicate little touches that make the OS feel more grown-up.



Above: Thumbnails now give you a peek at the contents of a folder.



Above: Snap Layouts lets you choose your desired layout with a keyboard shortcut.

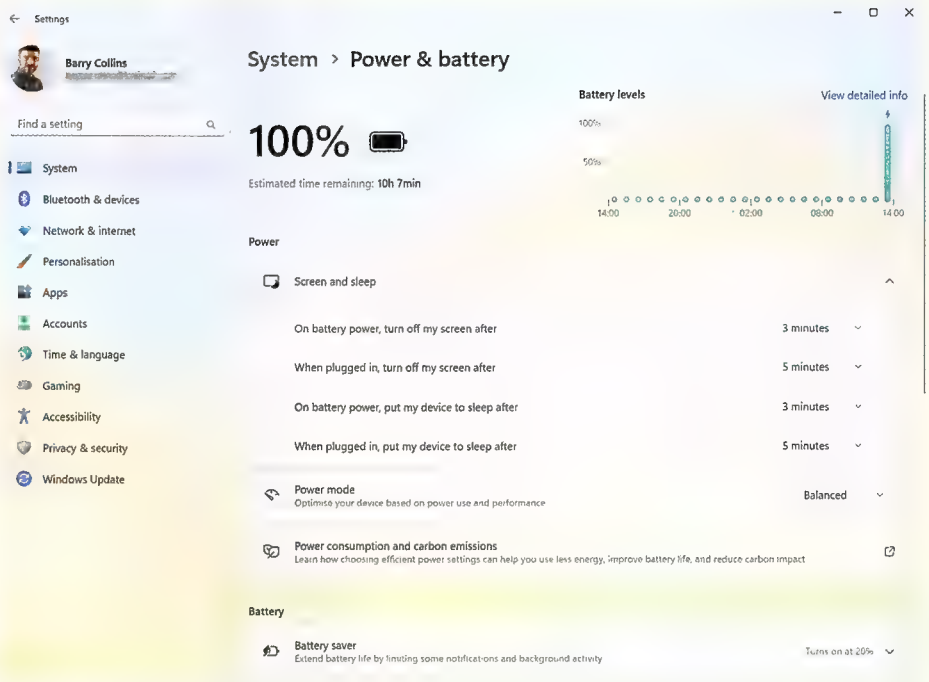
MORE AGGRESSIVE SCREEN AND SLEEP SETTINGS

We told you Microsoft was on an eco-drive. That extends to the new screen and sleep settings, which kick in more quickly to prevent you wasting battery on unattended devices. The screen will now turn off and sleep mode activated after only three minutes when a laptop is running on batteries, rising to five minutes if the device is plugged in.

That's a significant energy saving from the previous defaults, which when on battery power turned the screen off after five minutes and waited a whole 15 minutes to put the device to sleep. With power, it was ten and 30 minutes respectively. You can, of course, adjust the defaults if you have a genuine reason not to put the device to sleep so quickly, but in one stroke Microsoft could save a chunk of energy.

In addition to this, the Power & battery settings also benefit from a link to find more information about power consumption and carbon emissions. That link wasn't active in the beta version, but might be worth a look when the OS is released.

Finally on the power front, you can now hover over the battery indicator in the System Tray and get a tooltip showing the estimated remaining life of the battery.

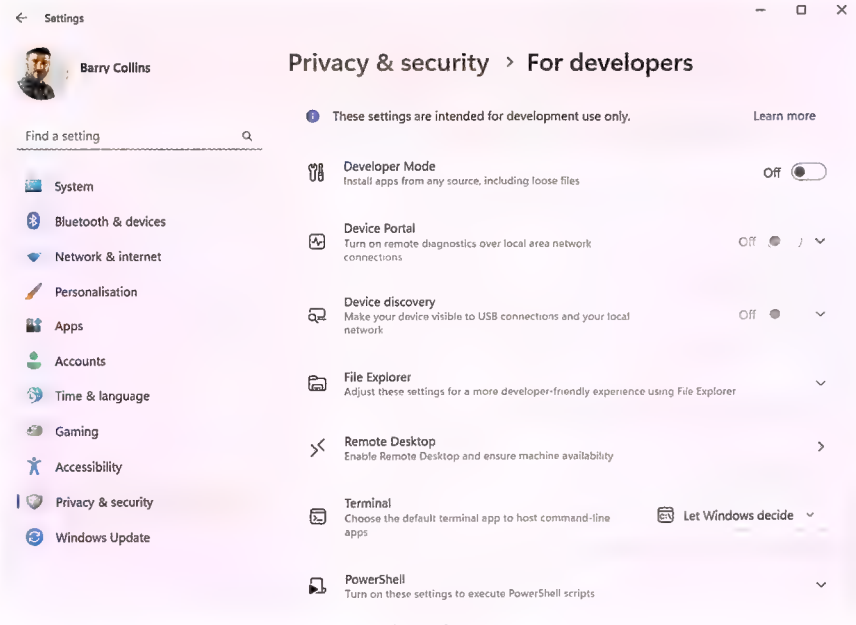

Settings
Barry Collins
Find a setting
System
Bluetooth & devices
Network & internet
Personalisation
Apps
Accounts
Time & language
Gaming
Accessibility
Privacy & security
Windows Update
System › Power & battery
100%
Estimated time remaining: 10h 7min
Battery levels
View detailed info
Power
Screen and sleep
On battery power, turn off my screen after 3 minutes
When plugged in, turn off my screen after 5 minutes
On battery power, put my device to sleep after 3 minutes
When plugged in, put my device to sleep after 5 minutes
Power mode
Optimise your device based on power use and performance
Balanced
Power consumption and carbon emissions
Learn how choosing efficient power settings can help you use less energy, improve battery life, and reduce carbon impact
Battery
Battery saver
Extend battery life by limiting some notifications and background activity

Above: Sleep mode is now activated after only three minutes when a laptop is running on batteries.

apps that you want maximum performance from. Microsoft claims you can get up to four times the responsiveness on a CPU-contended system when Efficiency mode is deployed.

The awkward bit here is that Efficiency mode is deployed on individual processes, not entire apps. So to put a process in Efficiency mode, you have to open Task Manager, then the individual app's tree group, and then right-click on a process you wish to put the brakes on. You wonder how many people will go to this effort, unless their system really is on its knees.

Some apps can automatically put processes in Efficiency mode. "Microsoft Edge and Chrome [are] experimenting with lowering base priority and applying power efficiency APIs to improve efficiency, which is similar to what Task Manager is doing to identify 'Efficiency mode' apps," said Microsoft in a blog post explaining the new feature. "You may see other apps with 'Efficiency mode' if they adapt to similar techniques to improve efficiency."



Above: Turn on Developer Mode and you can install apps from any source.

Developer settings

The new Privacy & security section of the Settings menu contains a section specifically aimed at devs. Here you'll find options to put the device into Developer Mode, which allows you to install apps from any source without Windows' built-in security getting shirty.

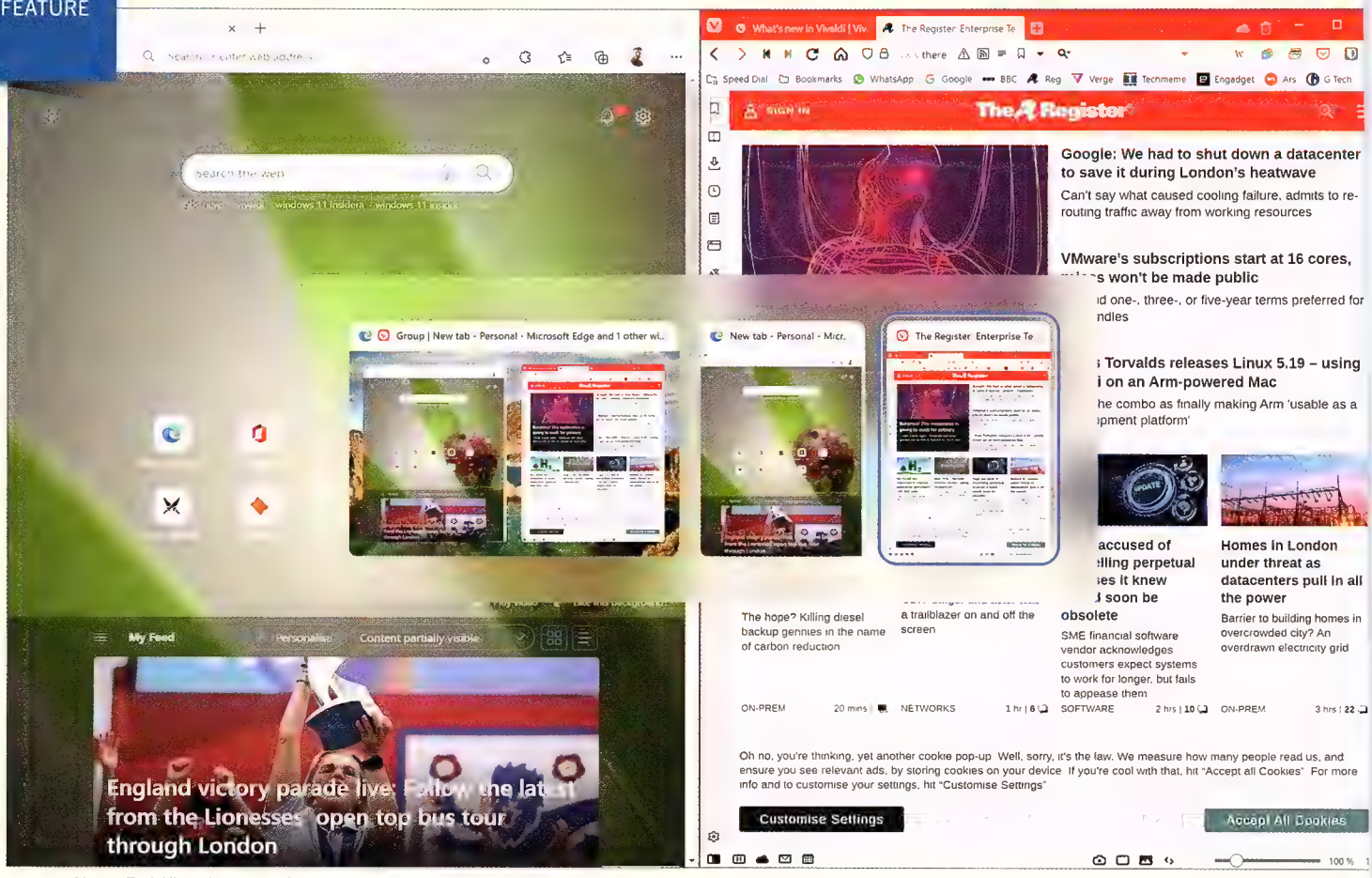
Also here is Device Portal, which switches on remote diagnostics for other Windows devices on the LAN. The Device discovery setting, meanwhile, makes your device visible to USB connections and other PCs on the local network.

The developer settings also let you make File Explorer nerdier than the average Windows dweller would desire. Here you can make Explorer show file extensions, hidden/system files, the full path in the title bar and empty drives.

Smart App Control

Smart App Control is yet another Microsoft effort to keep crapware off the platform. (Note to Satya: a clean-up of the Microsoft Store wouldn't go amiss.)

According to Microsoft: "When you try to run an app on Windows, Smart App Control will check to see if our intelligent cloud-powered security service can make a confident prediction about its safety. If the service believes the app to be safe, Smart App Control will let it run. If the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New tab - Personal - Micr.
The Register Enterprise Te
Google: We had to shut down a datacenter to save it during London's heatwave
Can't say what caused cooling failure, admits to re-routing traffic away from working resources
VMware's subscriptions start at 16 cores,
won't be made public
Torvalds releases Linux 5.19 – using on an Arm-powered Mac
Homes in London under threat as datacenters pull in all the power
Barrier to building homes in overcrowded city? An overdrawn electricity grid
The hope? Killing diesel backup gennies in the name of carbon reduction
a trailblazer on and off the screen
obsolete
SME financial software vendor acknowledges customers expect systems to work for longer, but fails to appease them
ON-PREM
NETWORKS
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ON-PREM
Oh no, you're thinking, yet another cookie pop-up. Well, sorry, it's the law. We measure how many people read us, and ensure you see relevant ads, by storing cookies on your device. If you're cool with that, hit "Accept all Cookies". For more info and to customise your settings, hit "Customise Settings"
Customise Settings
Accept All Cookies
My Feed
Content partially visible
England victory parade live: Follow the latest from the Lionesses' open top bus tour through London

Above: Task View shows your Snap Layouts in Snap Groups.

THE LITTLE THINGS

So end the bigger updates, but there are numerous little items that come with the Windows 11 22H2 update, too. Here's a quick summary.

APPLE AIRPOD IMPROVEMENTS

Good news if you're a user of Apple's earbuds – Windows 11 22H2 improves AirPod compatibility, specifically with support for wideband speech. So if you're using AirPods to make calls on your computer, you should sound a lot better to the people on the other end of the line.

SMARTER FLIGHT MODE SETTINGS

By default, banging Windows 11 into Flight Mode flicks off Wi-Fi and Bluetooth. However, that's no good if you've got a pair of noise-cancelling Bluetooth headphones to make the flight bearable. Microsoft hears you despite the low rumble of the engines, and so if you switch Bluetooth back on when you put the laptop in Flight Mode, it will leave Bluetooth running the next time you use Flight Mode, too. Sensible, although stroppy air stewards may quibble.

TASK VIEW SHOWS SNAP GROUPS

Welcome back to branding by Microsoft™. Remember those windows you moved into Snap Layouts earlier? Well, they're called Snap Groups. And now, when you Alt-Tab or enter Task View (Windows-Tab), those Snap Groups will be shown there too. The preview of the Snap Group even shows a bit of the background wallpaper to make them easier to distinguish.

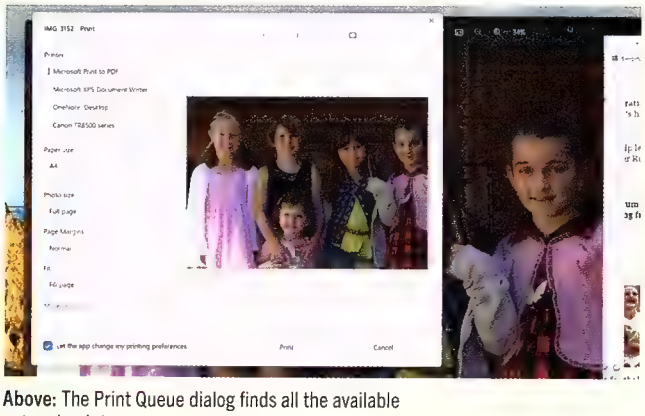
NO-INSTALLATION NETWORK PRINTERS

The Print Queue dialog has been given a lick of paint, but there's a change to printing that's more than cosmetic fluffiness. If there's a network printer that you haven't previously used, you don't need to go back to the Printer settings to get everything set up. When you hit Ctrl-P you should find any network printer available in the drop-down menu. When selected, it will be automatically installed. It worked perfectly in our tests with the beta.

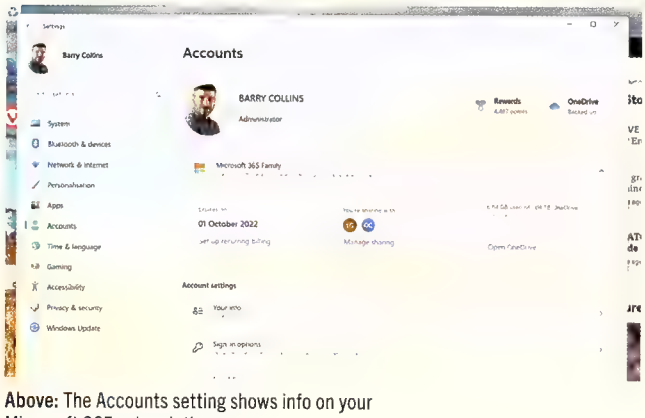
MICROSOFT 365 STATUS IN SETTINGS

We're not saying Microsoft's gagging to make Windows a subscription service, but under Accounts in Settings, you'll find an update on your Microsoft 365 subscriptions. It tells you when your subscription expires, lets you manage family members and provides another reminder of your available OneDrive storage, among other things.

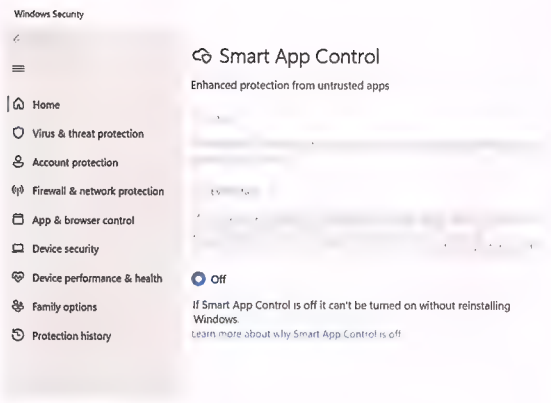
The direction of travel is obvious. It's now just a question of which company will blink first: Microsoft or Apple?



Above: The Print Queue dialog finds all the available network printers.



Above: The Accounts setting shows info on your Microsoft 365 subscription.



Above: Smart App Control only works on fresh installs and isn't turned on immediately.

app is believed to be malicious or potentially unwanted then Smart App Control will block it." Interestingly, Smart App Control won't let through any unsigned apps.

However, the way Smart App Control is implemented is odd, to say the least. It only works on fresh installs of Windows 11 and it's not switched on immediately. Your box-fresh PC is put into what's called Evaluation mode, "during which Windows tries to determine if you're a good candidate for Smart App Control. If you are a good candidate for Smart App Control, then it will automatically be turned on. If not, it will be turned off."

If Windows decides you're not a good candidate, that's it. You can't switch on Smart App Control manually. To even get another stab at Evaluation mode, you'll need to clean install Windows!

If you do pass Microsoft's mystery test, there's no means to override Smart App Control. If it decides an app is persona non grata, you can't tell Windows to let it through. All you can do is switch the entire system off or "contact the developer of the app and encourage them to sign their app with a valid signature". Good luck with the latter.

WHAT'S NEW FOR WINDOWS 10?

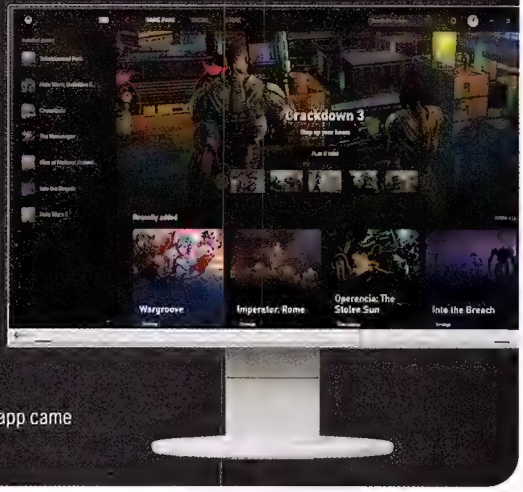
Windows 11 isn't the only operating system getting a 22H2 release. Windows 10 is still in active support, and Microsoft is lining up an update for that operating system too, although quite what it will contain remains something of a mystery.

At the time of writing, Microsoft was inviting business customers to test Windows 10 22H2, although the build that was released in late July was described by Microsoft as "focused on validating the servicing technology".

However, somewhat enigmatically, Windows chief Brandon LeBlanc's blog post also stated: "Windows 10, version 22H2 has a scoped set of features and Microsoft will share more details on this update later this year."

Quite what's meant by a "scoped set of features" isn't clear, but it seems highly likely that some of the new Windows 11 features mentioned in this feature are going to be added to Windows 10, too. Microsoft has form here. Several of the features that were initially announced for the launch of Windows 11 were later ported to Windows 10, including DirectStorage for the fast loading of games, cloud gaming via the Xbox app and the redesigned Windows Store.

It's hard to predict which bones will be thrown at Windows 10 users this time. It's likely new features will be rolled out as an enablement package to Windows 10 Insiders. Until they are, there seems little point in wasting effort validating Windows 10 22H2 in your business.



Right: Cloud gaming via the Xbox app came to Windows 10 last time around.

AND FINALLY...

ANDROID APPS AT LAST

It's not a confirmed feature yet, but more than a year after they should have arrived as part of the initial Windows 11 launch, it looks like Android apps will finally make the cut for 22H2.

Microsoft has been testing Android app support with Windows Insiders, although only those with Microsoft accounts registered in the US have been able to take part at the time of going to press.

The Android apps are, somewhat curiously, being supplied via the Amazon Appstore, which suggests that Google isn't entirely happy about this arrangement. The Amazon Appstore apps are already a subset of the total Android app market, and developers will have to specifically choose to make their apps available to Windows, which will make them a subset of a subset. In short, if you're banking on your favourite Android app being available on Windows 11, don't get your hopes up. ■

Right: Android apps could finally be available on Windows, but the feature is as yet unconfirmed.

PC BUILDER

System News

Does a new platform and core architecture make for a successful launch? Either way, Mark Williams is excited.

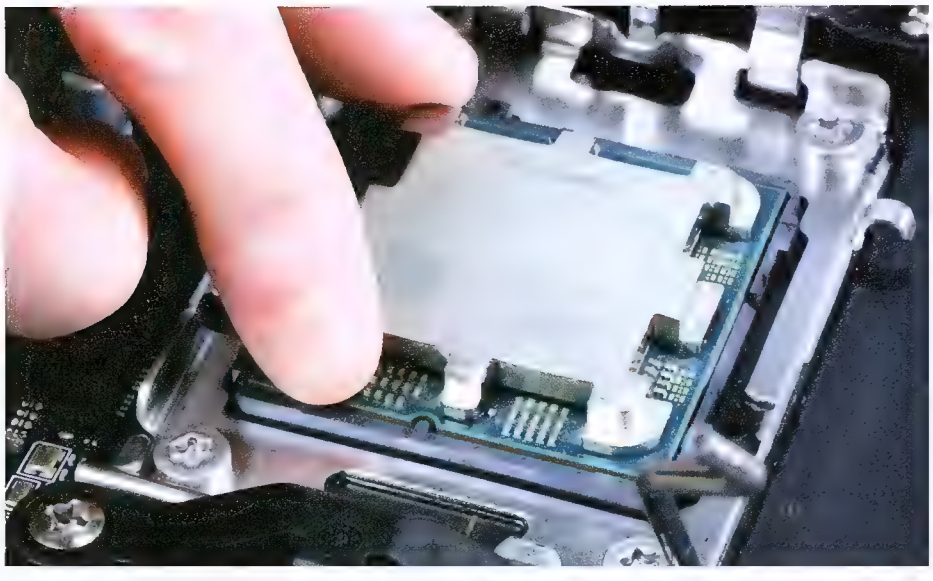
Mark Williams
Mark is an IT professional with a strong interest in voiding warranties.

AMD has announced what to expect from its Ryzen 7000 series processors, and with availability from September 27th, by the time you read this, chances are you'll be able to pre-order, if not get your hands on one of these new CPUs. AMD is sticking to its current core counts for the new series with the top 16-core 7950X (5.7GHz peak boost), the 12-core 7900X (5.6GHz), the 8-core 7700X (5.4GHz) and the 6-core 7600X (5.3GHz). A notable change here is the 7700X naming scheme for the 8-core part, possibly meaning AMD is saving the 7800X name for a future 3D V-Cache enabled gamer focused product further down the track.

The most exciting thing about the 7000 series are the final boost clock speeds. With current Zen 3 parts maxing out at 4.9GHz, the new Zen 4 enabled 7950X will boost up to 5.7GHz! That's a huge generational leap in clock speeds, and puts these in a record-breaking class of their own for consumer CPUs.

AMD is also claiming a 13 percent generational uplift in IPC with Zen4 over Zen3. Combined with the large frequency bump it is expecting users to see around a 35 percent increase in overall performance. Huge performance gains gen-on-gen. Along with the 7000 series launch comes the launch of AMD's new AM5 platform. It'll be similarly supported for a long time like AM4 was, at least to 2025 and possibly beyond. That's great news to hear as AM4's longevity has been one of AMD's great advantages over Intel's platforms.

> "The most exciting thing about the 7000 series are the final boost clock speeds. With current Zen 3 parts maxing out at 4.9GHz, the new Zen 4 enabled 7950X will boost up to 5.7GHz! That's a huge generational leap"



New X670E and X670 motherboards will launch at the same time to support it with cheaper B650E and B650 coming in October, all finally offering PCIe 5.0 connectivity for AMD systems. X670E motherboards will offer a staggering amount of IO options, from dual PCIe 5.0 x16 slots, to multiple PCIe 5.0 M.2 slots, up to fourteen 20Gbps USB ports natively, Wi-Fi 6E and much more.

The past couple of years have been great in the CPU space and with the core wars really beginning to ramp up with this launch and the soon to come 13th Gen Intel Raptor Lake parts, be sure to strap in and enjoy the performance ride everyone! ■

SHOP TALK

What is the rough sales split of AMD and Intel processors in the systems you're selling lately? Do you expect the upcoming Ryzen 7000 series to change those numbers with Intel's 13th gen hot on its heels?

Richard, Aftershock PC:
"Our split at the moment is about 50/50 between the two brands. It will depend a lot on what pricing the AMD CPUs come in at. Given that AMD has stated they will be running both generations side by side, you would think that the pricing will be quite a bit higher for the 7000 series. I do think there will be a shift towards the 7000 series for a while and then back towards Intel when each launch. From what I can tell, our customers are more excited to see what the new GPUs will be like than the new CPUs as plenty of current gen CPUs can handle pretty much any game at the moment anyway."

Market Watch

A sampling of PC systems available this month

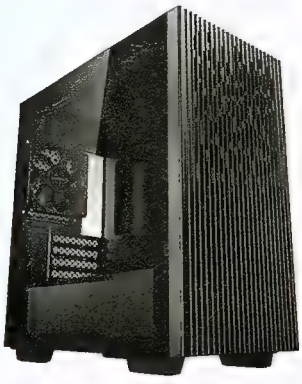
CPL ONLINE 12TH GEN INTEL I5 RTX 3060

$1,939 |tinyurl.com/APC512CPL

The sweet spot for a decent gaming PCs continues to fall back below the two-thousand-dollar mark. The 12400F processor in this rig is unmatched in this category, so, tick. The RTX 3060, like all RTX 3000 cards are a little overpriced but not as much as the top end, still a solid choice.

32GB of RAM is the big differentiator in this build, great for heavy multitaskers and provides a bit of future proofing. Though is seems to have come at the cost of SSD capacity. As long as your installed game library isn't too big this is a good choice for the price.

CPU: Intel Core i5-12400F; **Cooler:** OEM; **Motherboard:** Gigabyte B660M DS3H AX; **Graphics:** Gigabyte GeForce RTX 3060 Aorus Elite 12GB; **Memory:** CORSAIR Vengeance LPX 32GB DDR4 3200MHz; **Storage:** Samsung 980 500GB M.2 NVMe SSD, Seagate Barracuda 2TB HDD; **Power Supply:** EVGA 700 GQ 700W; **Case:** Antec DF600 Flux.



TI COMPUTERS WINNING GAMING 3060 SUPER

$1,795 | tinyurl.com/APC512TIC

Coming in over one hundred dollars cheaper than the CPL system, this system trades RAM capacity for more SSD storage. Arguably the better combination for gamers. 16GB is still plenty for any game and the extra SSD capacity will allow more games to be installed at once.

The motherboard is sporting the entry level H610 chipset though and as such has less IO options, in particular rear USB ports (just four!) so be mindful of that. As long as the motherboard shortcomings don't affect you this is about as perfect a price to performance build you will find.

CPU: Intel i5 12400F; **Cooler:** Deepcool Super; **Motherboard:** Asus Prime H610M-E; **Graphics:** Geforce RTX3060 12GB; **Memory:** 16GB DDR4 RGB 3200MHz; **Storage:** 1TB NVMe M.2 PCIE SSD; **Power Supply:** Cooler Master 750W; **Case:** DeepCool Matrexx 40.

AFTERSHOCK PC ZEAL - PRO

$3,650 | tinyurl.com/APC512AFT

Two white themed systems at about the same price? This and the Scorptec system are quite similar in many respects. Aimed at the sensible enthusiast gamer this ticks all the right boxes. An eight core CPU with watercooler, high end chipset motherboard, 32GB of RAM and 1TB of storage.

Splitting the two gets interesting when looking further at the details. Faster RAM, larger secondary HDD and PSU start to swing things in this system's favour, but the biggest devisor is the step down here in graphics card model to the RTX 3070 Ti. With all the above costing $50 extra, this system is only worth considering if RAM speed and secondary storage space are of primary importance to you.

CPU: Intel Core i7-12700KF; **Cooler:** Nzxt Kraken X73 AIO; **Motherboard:** Gigabyte Z690 Ultra Durable AX; **Graphics:** Gigabyte RTX 3070Ti Gaming OC 8GB; **Memory:** 32GB Corsair Vengeance Pro RS RGB 3600MHz; **Storage:** 1TB Gen4 Samsung M.2. NVME, 4TB Western Digital HDD; **Power Supply:** 850W Cooler Master MWE V2; **Case:** Antec P120 Crystal.

SCORPTEC COMPUTERS FLUX RTX 3080

$3,599 | tinyurl.com/APC512SCO

Sticking with the white enthusiast gamer theme, this system starts off equally as well as the Aftershock system with the ideal Intel gamer 12700KF CPU. Good motherboard and water-cooling will keep it happy too.

This system appears to be hard up against the wall with its relatively slower RAM speeds, smaller power supply and HDD, though these are relatively minor downgrades for the huge +15-20 percent benefit in games of stepping up to the RTX 3080 graphics card. Being $50 cheaper, it makes this system the easiest to recommend purely for gaming.

CPU: Intel Core i7 12700KF; **Cooler:** Cooler Master MasterLiquid ML240L v2 White ARGB AIO; **Motherboard:** Gigabyte Aero Z690-G; **Graphics:** Gigabyte Vision GeForce RTX 3080 OC 10GB; **Memory:** Corsair Vengeance RGB Pro White 32GB 3200MHz DDR4; **Storage:** Samsung 970 Evo Plus 1TB M.2 SSD, Seagate Barracuda 2TB HDD; **Power Supply:** SilverStone Decathlon 750W; **Case:** Be Quiet! Pure Base 500DX White ATX.

PC BUILDER

Blueprints

Value- and performance-driven hypothetical builds

BUDGET

A perfect balance between price and peformance.

With a total price generally around the $1,500 to $2,000 mark, our budget builds regularly see components changing due to sales of cheaper parts. Luckily, both builds continue this trend with our most expensive of the bunch costing just over $1,700. Kicking off with our AMD budget rig, we have a change in the motherboard. Out goes the Gigabyte B550 Aorus Elite AM4 and in comes MSI's B550M Pro-VDH. At $149, the MSI alternative was too good to pass up. Regardless of it being a Micro-ATX, it's still compatible with our components.

Prices fell slightly across the AMD machine, including on our GPU. We upgraded our GPU to the PowerColor Radeon RX 6650 XT Hellhound OC 8GB RDNA 2 card for some easy out-the-box overclocking. At $599, it's a brilliant budget-end GPU with more than enough power for a solid 1080p gaming experience. All other components on the AMD side remain the same, with a few price fluctuations.

On team Intel, most of the components are on sale or reasonably priced. One area we did swap out was the GPU. The Gigabyte Eagle OC 3060 card is still widely available for around $600, but we replaced it with another GeForce RTX 3060 OC card, a 12GB MSI Ventus 3X. It's a little cheaper and we've gained 4GB of GDDR6 VRAM, which should allow us to bump up those sliders in games.

The overall cost of the Intel machine goes from $1,801 to $1,711, and we get 4GB more of gaming potential out of the graphics card. In the realms of capacity, we have stuck with the same SSD/HDD combo as previously featured. The 500GB MSI Spatium M450 PCIe 4.0 drive is still an excellent grab at $100 for your main storage solution, whereas the Seagate Barracuda HDD has all the backup storage you'll need at 4TB of capacity.

"We upgraded our GPU to the PowerColor Radeon RX 6650 XT Hellhound OC 8GB RDNA 2 card for some easy out-the-box overclocking. At $599, it's a brilliant budget-end GPU with more than enough power for a solid 1080p gaming experience."

AMD INGREDIENTS

Part		Price
Case	Corsair 4000D Airflow	$120
PSU	550W Corsair CV550 80+ Bronze	$75
Mobo	MSI B550M PRO-VDH WiFi AM4 NEW	$149
CPU	AMD Ryzen 5 5600X	$329
GPU	PowerColor Radeon RX 6650 XT Hellhound OC 8GB RDNA 2 NEW	$599
RAM	16GB (2 x 8GB) Corsair Vengeance LPX CL16 @ 3600MHz	$110
SSD	500GB MSI Spatium M450 PCIe 4.0 M.2 SSD	$99
HDD	4TB Seagate Barracuda HDD	$120
OS	Windows 10 Home 64-bit OEM (Windows 11 Compatible)	$60
Total		$1,661

INTEL INGREDIENTS

Part		Price
Case	Corsair 4000D Airflow	$120
PSU	550W Corsair CV550 80+ Bronze	$75
Mobo	Asrock B660 Pro RS LGA 1700	$179
CPU	Intel Core i5-12600	$369
GPU	MSI GeForce RTX 3060 Ventus 3X OC 12GB NEW	$579
RAM	16GB (2 x 8GB) G.Skill Ripjaws V CL16 @ 3600MHz	$110
SSD	500GB MSI Spatium M450 PCIe 4.0 M.2	$99
HDD	4TB Seagate Barracuda HDD	$120
OS	Windows 10 Home 64-bit OEM (Windows 11 Compatible)	$60
Total		$1,711

"Regular readers of this magazine will no doubt have noticed our excitement at graphics cards returning to normal prices, but this month, they've actually started to go below RRP."

MID-RANGE

A game-ready machine that can also handle demanding work.

This month's mid-range build is a story of price cuts, allowing you to either save money on your build or get more bang for your buck. But before we get to that, we've decided to give our mid-range case a refresh, based on the arrival of Nzxt's H7 range. As the name suggests, it's built around airflow with a mesh front that allows air to pass through the system and keep it cool. We had some concerns about airflow on the higher-end model, so the H7 Flow looks like the best case to go for from this range.

Regular readers of this magazine will no doubt have noticed our excitement at graphics cards returning to normal prices, but this month, they've actually started to go below RRP. Last month, the Asrock Radeon RX 6800 XT Phantom Gaming D 16GB hit the $1,099, but it's now $240 cheaper at $859. We've included that card in our AMD build for now, but we're already starting to think about the Asrock Radeon RX 6900 XT. This is the next model up and offers about 10 percent more performance. Previously, the 6900 XT has been a lot more expensive than the 6800 XT, but now it's roughly 10 percent more expensive, the performance gain is in line with the price premium, making it a no-brainer if you have the money.

On the Nvidia side in our Intel build, our RTX 3070 card has not decreased in price. This reflects AMD's agressive push to lower pricing for cards based on its GPUs, while Nvidia appears to be trying to keep prices up, or at least steady. Otherwise, the components in our build this month have remained unchanged with little movement anywhere in the price of CPUs, RAM, or storage. New processors and GPUs are being readied, so we can look forward to some bargains at the mid-tier price level in forthcoming months.

AMD INGREDIENTS

Part		Price
Case	Nzxt H7 Flow NEW	$209
PSU	750W EVGA SuperNova 750 GT 80+ Gold	$149
Mobo	Asrock X570 Steel Legend AM4	$299
CPU	AMD Ryzen 7 5800X	$329
Cooler	Cooler Master MasterLiquid ML240L RGB V2	$95
GPU	Asrock Radeon RX 6800 XT Phantom Gaming D 16GB	$859
RAM	32GB (2 x 16GB) Corsair Vengeance RGB RT CL16 @ 3600MHz	$279
SSD	500GB WD Black SN850 NVME M.2 PCIe 4.0 SSD	$109
HDD	4TB Seagate Barracuda	$120
OS	Windows 10 Home 64-bit OEM (Windows 11 Compatible)	$60
Total		$2,508

INTEL INGREDIENTS

Part		Price
Case	Nzxt H7 Flow NEW	$209
PSU	750W EVGA SuperNova 750 GA 80+ Gold	$149
Mobo	Asrock Z690 Pro RS LGA 1700	$299
CPU	Intel Core i7-12700F	$519
Cooler	Cooler Master MasterLiquid ML240L RGB V2	$95
GPU	MSI Ventus 2X OC GeForce RTX 3070 8GB	$829
RAM	32GB (2 x 16GB) Corsair Vengeance RGB RT CL16 @ 3600MHz	$279
SSD	500GB Corsair MP600 Pro LPX M.2 PCIe 4.0	$129
HDD	4TB Seagate Barracuda	$120
OS	Windows 10 Home 64-bit OEM (Windows 11 Compatible)	$60
Total		$2,688

"Nzxt's Kraken X73 manages to sneak its way into our AMD Turbo machine too, having made a good impression."

TURBO

The maximum PC.

Last but not least, especially when it comes to performance, we have our Turbo machines. In the previous issue, we saw a few changes occurring in the Intel rig but not many over in the AMD corner. This time around we only see two changes for the Intel PC including the GPU once more and the CPU cooler. We have swapped out our MSI Gaming Trio card for Gigabytes Gaming OC 3090Ti. Purely on the basis that it was available for a lower price, it makes total sense to add it in. Plus we get the added speed benefits of this being an OC.

As for the cooler, we have saved some more cash by swapping out our previous MSI AIO for Nzxt's Kraken X73 360mm cooler. We recently featured the RGB variant and this great-looking item performs efficiently to keep our temperatures low.

Nzxt's Kraken X73 manages to sneak its way into our AMD Turbo machine too, having made a good impression. Our GPU from last month, the Asrock Radeon RX 6900 XT Phantom Gaming D 16GB, is now difficult to find and has been replaced by the more common and still well-priced Gigabyte Radeon RX 6900 XT Gaming OC 16GB.

In another change for the same reason, we've swapped out the now rare Gigabyte X570 Aorus Elite WiFi motherboard for a MSI MEG X570 Unify, which is excellent value at $389.

And once again, all things are very much not equal. Take the outragously priced Nvidia 3090 Ti out of the Intel rig and things balance well across the rest of the components – but at over twice the price of the generally similarly performing AMD Radeon 6900XT, it's crazy that top-end Nvidia cards are still selling for such obscene prices. We hope this situation goes away soon.

AMD INGREDIENTS

Part		Price
Case	Phanteks Enthoo Pro 2 Tempered Glass	$220
PSU	850W Corsair HX850 80+ Platinum	$270
Mobo	MSI MEG X570 Unify NEW	$389
CPU	AMD Ryzen 9 5950X	$929
Cooler	Nzxt Kraken X73 73.11 CFM 360mm NEW	$239
GPU	Gigabyte Radeon RX6900 XT Gaming OC 16GB NEW	$1,099
RAM	64GB (2 x 32GB) G.Skill Trident Z RGBDDR4 @ 4000MHz CL18	$489
SSD	1TB WD Black SN850 M.2 PCIe 4.0	$189
HDD	6TB WD Blue 5400 HDD	$189
OS	Windows 10 Home 64-bit OEM (Windows 11 Compatible)	$60
Total		$4,073

INTEL INGREDIENTS

Part		Price
Case	Phanteks Enthoo Pro 2 Tempered Glass	$220
PSU	850W Corsair HX850 80+ Platinum	$270
Mobo	Asus TUF Gaming Z690-Plus WIFI DDR5 LGA 1700	$389
CPU	Intel Core i9-12900K	$899
Cooler	Nzxt Kraken X73 73.11 CFM 360mm NEW	$239
GPU	Gigabyte GeForce RTX 3090 Ti GamingGaming OC 24GB NEW	$2,399
RAM	64GB (2 x 32GB) G.Skill Ripjaws S5 DDR5 @ 5600MHz	$589
SSD	1TB Adata XPG Gammix S70 M.2 PCIe 4.0	$225
HDD	6TB WD Blue 5400 HDD	$189
OS	Windows 10 Home 64-bit OEM (Windows 11 Compatible)	$60
Total		$5,479

WINDOWS

Customise Windows 11 with your own widgets

Want to spruce up your desktop with live information and other handy gadgets? Nik Rawlinson explains everything you need to know, including a step-by-step guide.

BeWidgets has a small selection of smart-looking widgets,

Over the years, Microsoft has tried a few different ways of providing at-a-glance information inside the main Windows interface. In Windows Vista and 7 we had gadgets, which then turned into Live Tiles in Windows 8 and 10. Those disappeared in the move to Windows 11, to be replaced by a set of widgets that live in their own slide-out drawer.

Windows 11 is limited to a curated selection of built-in widgets, but that will soon be changing. Microsoft recently announced that developers will be able to start creating their own widgets for Windows 11 this year, using a framework called Adaptive Cards. If you're fluent in JSON you can try it out now at **adaptivecards.io**.

Not everyone wants to get hands- on with code, however, and frankly not everyone loves Windows 11 widgets anyway. Rather than hiding information away in a panel, there's much to be said for the old way of displaying widgets on the desktop, especially in these days of huge 4K screens. Happily, there are several third-party tools that can do just that.

Widget Launcher

tinyurl.com/APC512WL

Widget Launcher is a simple, free utility that adds a selection of floating widgets to the Windows desktop. You can choose whether they sit above or below windows, and in many cases you can customise their appearance.

The available widgets cover a good spread of functions: you can check on your CPU and RAM usage, keep an eye on the time in multiple locales, track the weather forecast and even convert currencies directly on your desktop. Some widgets support multiple instances, so for example you could have several different Notes widgets open at once, or two different Calendar widgets showing different time periods and events.

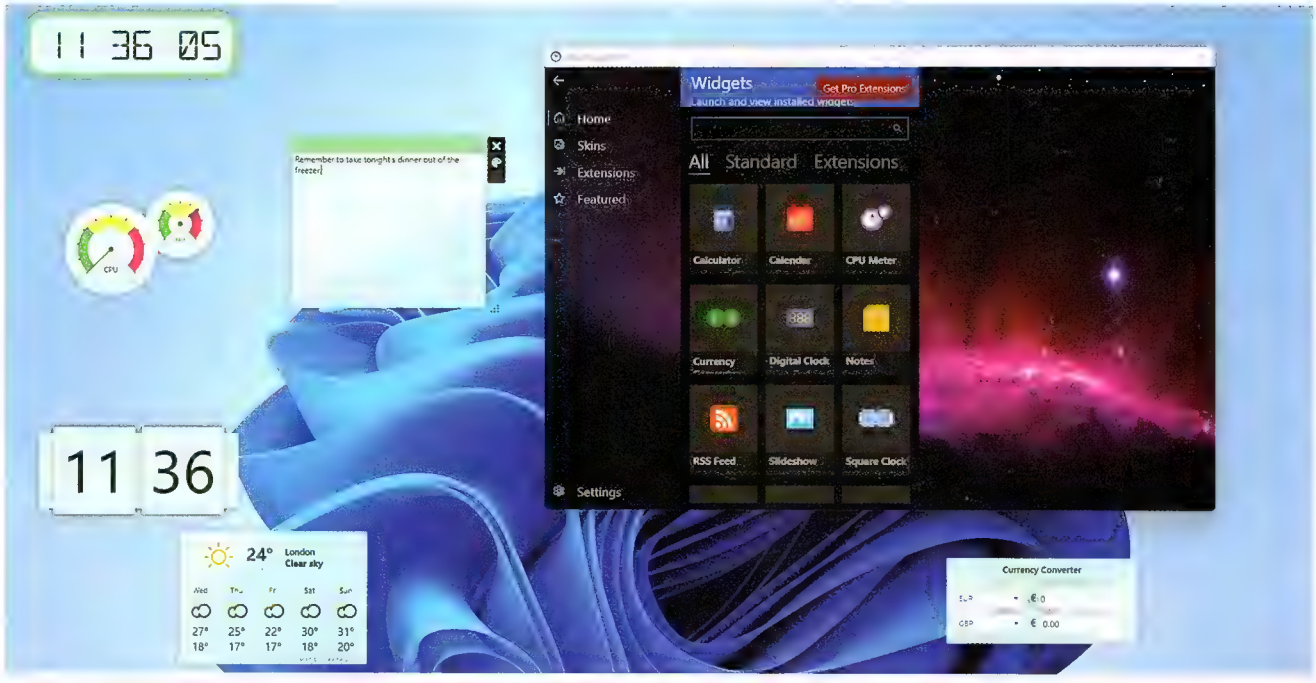
Once you've got your widgets set up, the Launcher app remembers your widget settings and locations, so when you restart your PC, all widgets will reappear in their former locations, with contents – such as text in the Notes widget – still in place. You can add extra widgets, including a dictionary, translator tool and photo frame, via the optional $3,79 Pro Widgets extension (**tinyurl.com/APC512WLPRO**) that builds on its core skills.

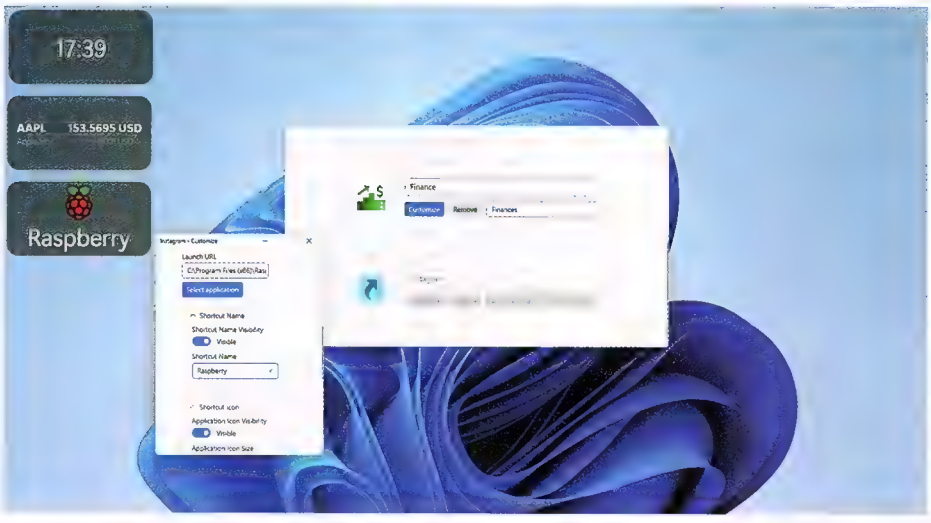
BeWidgets

tinyurl.com/APC5128G

BeWidgets has a smaller selection of widget types than Widget Launcher, but they look great. You can pick from time and date displays, photo galleries, finance, weather and app shortcuts, with customisations for each such as the location for your forecast.

You can set the height and width of each widget, and choose whether it's locked or movable. The app uses the same visual style as Windows 11, so it integrates seamlessly with your





desktop, and you can automatically generate a colour scheme based on your current Windows settings.

When you've set up several widgets and positioned them as you like, you can save your layout and bring it back with a single click at a later date. However, we found things got a little glitchy once we started trying to store multiple layouts, as switching between them caused our widgets to disappear altogether.

8Gadget

8gadgetpack.net

Launching 8Gadget is like winding back the clock. Its widgets have a glossy retro look that stands out in this age of muted colours, transparency and flat design. You can even choose to keep them in a sidebar, where they used to live in Windows Vista, though if you add too many gadgets for the sidebar, they slip onto a second pane where they're not immediately visible. Still, you can reorder widgets, and move them between sidebar pages by dragging them beyond the top or bottom of the stack.

You can't customise your widgets' appearance as you can with Widget Launcher and BeWidgets, but the selection of 61 gadgets includes several that duplicate the same basic functions, so you can pick those that best suit your style. For example, there are five weather gadgets and seven clocks, separate from the calendars and agendas. With a little careful curation you can get your preferred selection of mini apps quietly running away in the background.

Top: 8Gadget lets you place widgets on the desktop or in a sidebar. **Above:** Widget Launcher is free, but a premium extension is available.

You can tweak the information that's shown: the weather gadget can be customised for your local area (or somewhere else if you're planning a holiday), while the process monitor lets you select which processes are included, as well as the colours used.

The 8Gadget organiser, in which you pick the gadgets you want to show, doesn't need to be running for your gadgets to remain active, and when you close it, it disappears, leaving the gadgets behind. You can restore it by launching 8GadgetPack Tools from the Start menu and clicking Add Gadget. The Tools interface also lets you disable the sidebar, and reassign Windows-G to launch your gadgets, if you're not already using this shortcut to access the Windows Game Bar.

Live Tiles Anywhere

tinyurl.com/APC512LT

Live Tiles were one of the defining features of Windows 10, but with Windows 11 they're gone. If you want them back, Live Tiles Anywhere is the answer – and it's arguably more useful than the original implementation, as it puts Live Tiles directly on the desktop rather than hiding them away in the Start menu.

Creating a tile is a simple case of working your way through a wizard and selecting what the tile should link to. At its simplest you can launch an installed app with a click or open a specific web page. However, things get more interesting and more useful when

your selected program has live updates, as with the Money and Weather tiles (see image, below). You can define a visual style for your tile or have the program automatically pick it up from the tile contents.

Rainmeter

rainmeter.net

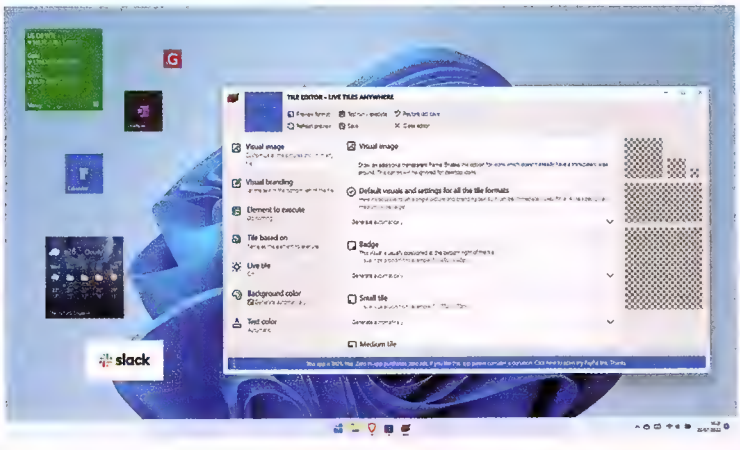
Don't be fooled by Rainmeter's name. While you can certainly use it to enliven your desktop with weather-related widgets, its skills go far beyond this.

Rainmeter refers to its widgets as "skins" for different data readouts, but they work just like any other desktop gadget. Each skin displays a defined set of information, or a shortcut to a simple task such as sending a search term to Google. Seven skins come preinstalled, which you can enable and disable from the context menu on any gadget, or through the System Tray app.

The skins themselves are small and neat, with a "quiet" appearance. You can drag them wherever you choose, but if you bring one within a few pixels of a neighbouring skin it will snap into position, helping to keep your desktop tidy. When you close a skin, its position is saved, and it will reopen in that spot the next time you open it. You can also turn this option on and off on a skin-by-skin basis, as well as tweaking transparency and hover-over behaviour, and setting whether each gadget should be always on top.

Rainmeter isn't just about pre-written skins, however: it's also extensible, allowing anyone to create their own gadgets using nothing more than a text editor such as Notepad. There are dozens of third-party skins you can freely download and add to your own Rainmeter installation – the Rainmeter forums are a good place to find them (**forum.rainmeter.net/viewforum.php?f=27**). You can even write your own, using the documentation at docs.rainmeter.net/manual/skins – we've used this as a reference in creating our own widget, as shown in the box on the right, which displays a random photo from our library. ■

Below: Live Tiles Anywhere brings back a much missed part of Windows 10.
Bottom: Rainmeter's skins are understated and attractive.



CREATE A RANDOM IMAGE CAROUSEL IN RAINMETER

1 Right-click the Rainmeter icon in the System Tray and select Manage. Make sure the Skins tab is active and click the folder icon to the right of the "Active skins" drop-down menu to create a new skin. Click "Add folder"; Rainmeter will now create a folder called NewFolder. Press Return to accept this name, click "Add skin" and Rainmaker will create a skin called NewSkin.ini. Press Return to accept the name; you can rename both the folder and the skin, but we'll keep the default names just for clarity. Click Close.

2 Click NewSkin.ini in the left-hand pane of the Manage dialog, then click the Edit button. This opens the skin definition file in your default text editor. You'll see a line saying "Update=1000": this tells Rainmeter how often to refresh the content of your skin, in milliseconds. This is probably too often for an image carousel, so change the number to 300000 – now it will update every five minutes. If you're creating a skin for distribution, you might also add some credits to the Metadata section below, but we can leave those blank for now.

3 The section at the bottom of the file holds the code that makes the skin work. Delete the placeholder [MeterString] line, and the default line of code below it; in their place, enter the lines:

```
[MeasureImage]
Measure=Plugin
Plugin=QuotePlugin
PathName=C:\Users\nik\OneDrive\Pictures\originals\
```

In the last line, substitute the path to a folder on your system that contains photos. This code tells Rainmeter that you want to use the measure function to derive the dimensions of an element passed to it by a plugin – specifically the QuotePlugin, which takes either a random line from a text file or a random file from a folder. The file is taken from the folder specified by the PathName variable.

4 Now, leave a blank line beneath your Path variable and add a new section as follows:

```
[ShowImage]
Meter=Image
MeasureName=MeasureImage
W=400
PreserveAspectRatio=1
```

This code tells Rainmeter to use the Image function to take the output of the MeasureImage function and display the image with a width of 400 pixels. Save your file and close it. Now, with the NewSkin.ini file still selected in the Manage dialog, click Load. You should see a random image from your specified folder displayed in a floating frame on your desktop; in five minutes, it will be replaced by a new one. ■

QUICK TIPS

The problem solvers

The APC team field problems across the spectrum of devices and software. Learn a new trick or fix you can use.

VPN confusion

I looking at ways I can make my own VPN, but I'm slightly confused about WireGuard VPN. Do I have to install this software on my network server, or can I run it just on a desktop or laptop? WireGuard's website is confusing too. On the subject of browser fingerprinting, couldn't I just use my DuckDuckGo browser? I would greatly appreciate any information.
Ariana Arsenault

APC responds: The key thing about VPNs is that there are two basic types: client-based, where you encrypt your internet connection using a third-party provider, and server-based, where you configure a VPN server on your home network. This then allows you to 'dial in' securely and connect to your local network while away from home. Once connected, you have full access to the network and its resources, shared folders, and printers as if you're at home.

"Thanks to the great leap forward brought about by USB 3.0, it's feasible to run Linux (or indeed Windows) from an external SSD drive."

If you wish to encrypt your internet connection when connected to a public Wi-Fi network, you need a VPN provider that offers Wireguard as a protocol, such as NordVPN, WindScribe, or CyberGhost.

If you're looking to create a VPN server, you'll need to install this on your home network – typically on a device that's on 24/7, which can be a file server on your network or (if supported) your router. Check your router's instructions to see if it supports acting as a VPN server and what protocols it supports – right now, few routers support WireGuard.

In our opinion, it's simpler to hold off on implementing a Wayland VPN server right now and explore what other protocols your router supports. OpenVPN is the next best choice, but L2TP/IPSec will also do at a pinch – APC has such a VPN server configured on a Synology RT2600ac router for dialing home when required.

If you're determined to go ahead with a WireGuard VPN server given its superior performance and security, then if you're relying on your NAS or file server, consider exploring the Linuxserver.io Wireguard Docker image (**https://github.com/linuxserver/docker-wireguard**) – once configured, you can connect using the WireGuard app in client mode.

Moving on to your other query, it helps to understand what a browser fingerprint is, namely information about your browser (its type and version) as well as other information (your OS, active plugins, language, screen resolution, and so on) that is used to identify you online. Once identified, websites can use it to recognise who you are, track your behavior and serve up personalised ads (among other things).

The DuckDuckGo plugin aims to anonymise your online activity but doesn't hide your browser's unique fingerprint. Various browsers offer differing levels of protection against fingerprinting, from Firefox (part of its standard Enhanced Tracking Protection tools) and Brave (**https://brave.com**) to the gold standard for privacy and anonymity online, Tor (**www.torproject.org**).

If you're unwilling to give up your current browser, then look at CCleaner's Kamo (**www.ccleaner.com/kamo**), a tool that periodically 'randomises' your browser fingerprint plus offers other anti-tracking tools.

Small, light and the perfect external boot drive.

Corsair case shortcomings

I am in the process of building my next PC, based on Alder Lake. I'm getting to the point of connecting the front panel connectors, but the Corsair case doesn't have HDD LED or speaker cables.

Of more significant concern are the front panel USB cables. The case has USB 3.1 Type-C and USB 3.0 cables. However, the motherboard has a USB 3.2 Gen 2x2 Type C Front Panel connector and a USB 3.2 Gen 1 header. The 3.1 cable fits in the type C connector, but the 3.0 cable would not fit. Is there a workaround for this? Or am I stuck not being able to use some of my USB slots on my front panel?
Michael Borkowski

APC responds: Case speakers can, of course, be purchased separately. Search eBay for 'motherboard speaker' to pick one up for around $2-$3. Corsair's decision to drop HDD lights from its cases is not a new one, but still strange. Ultimately, you'll have to make do with picking up HDD LEDs for around $3-$4 online and then working out where you could place them so they're visible in the case window. You might want to consider a software-based solution instead, one that places an HDD activity light in the Taskbar notification area like Activity Indicator (**https://sourceforge.net/projects/activityindicat/**).

Regarding your second problem, it's worth noting that USB 3.2 Gen 1 is the new designation for USB 3.0. The

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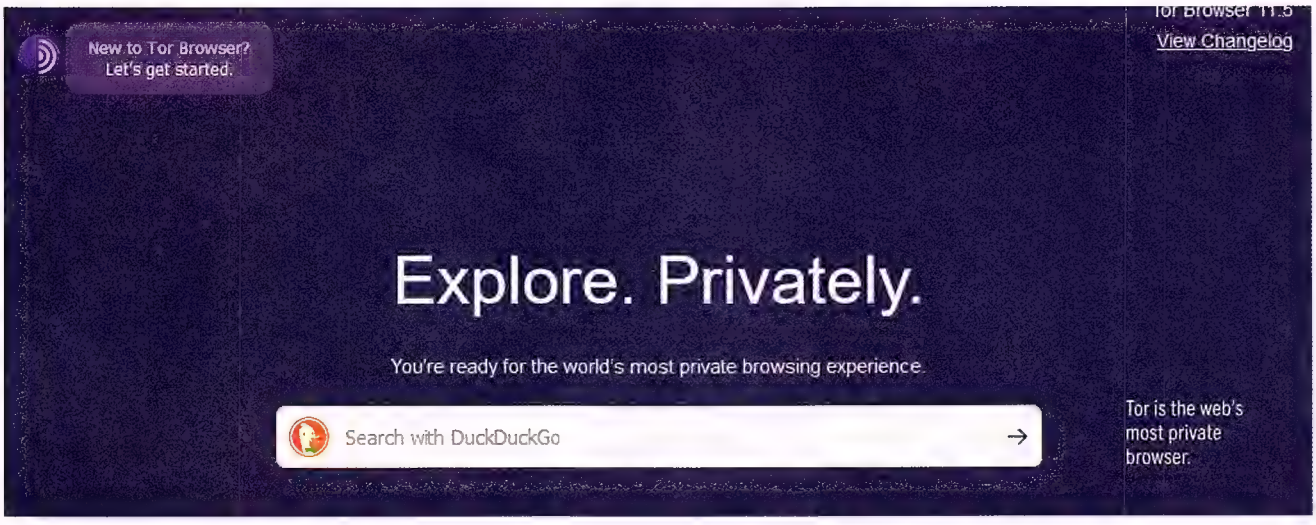

New to Tor Browser?
Let's get started.
Tor Browser 11.5
View Changelog
Explore. Privately.
You're ready for the world's most private browsing experience.
Search with DuckDuckGo
Tor is the web's most private browser.

USB 3.2 Gen 1 port on the Asus ROG Strix Z690-E is a standard 19-pin header that should fit any standard USB 3.0 connectors, including those on the 7000D. That said, your Corsair case ships with not one, but two USB 3.0 connectors, each capable of running two of the four available USB 3.0 ports, so you can only connect two ports via the mobo header.

Thankfully, this isn't an insurmountable problem. Look for a PCI-E card that offers additional USB 3.0 (or USB 3.2 Gen 1) headers – Weastlinks has a card with two 19-pin connectors that should give you access to all four ports. If you are still unable to plug in your connectors, check the pins on the case cables as they may be bent or damaged.

Terminal disconnect

I was upgrading my Ubuntu 20.04 LTS server to 22.04 via the cockpit web interface. Part way through the process I nicked off for a coffee, only to come back and find I'd been logged out of cockpit. I thought the installation had finished because the login screen said Ubuntu 22.04, but I hadn't rebooted.

I logged back in and checked for software updates, but whether using cockpit's tool or 'apt get update' in Terminal, I was told jammy had control of apt update. I've waited about 20 minutes and it hasn't let go. I'm afraid to reboot because I can't see what's happening behind the scenes. What can I do?
William M Brown

APC responds: Ah, the joy of losing your cockpit session because you wandered off only to discover you've lost your place when you got back. In this case, you're right to be wary, because being disconnected usually coincides with a pause in whatever process you're doing. Thankfully, you can restore the previous cockpit Terminal session with a simple command:

```
sudo screen -D -r
```

This will take you back to where you left off, where you'll almost certainly discover that the installer is waiting for a response from you – possibly to remove obsolete packages after the installation has finished. Finish the job, then reboot and you should have control of updates once more.

MakeMKV error

Whenever I launch MakeMKV it seems to hang for a while, then throws up a 'No answer from MakeMKVCon' error. I close it and try again, but the same problem. Sometimes, if I open Task Manager to the Details tab, I can see two processes: makemkv.exe, which vanishes after I close the error message, and makemkvcon64.exe, which sticks around for 30 seconds. If I right-click makemkvcon64.exe, choose 'End Task', and wait a few seconds, I can sometimes get MakeMKV to load, but it's a frustrating process. What's the fix?
Lloyd Bryson

APC responds: This problem is often caused because you've set the MakeMKV data directory to a location that's no longer accessible, often a network folder. If you're able to open MakeMKV, select View > Preferences and check the destination folder under the General tab. If necessary, change this to a local folder and click OK. That should fix the problem.

If you're unable to get into MakeMKV to make the change, you can edit the setting via the Registry. Open Registry Editor and navigate to Computer\HKEY_CURRENT_USER\SOFTWARE\MakeMKV. Look for the app_DataDir value – this is the one that needs changing. Once done, you should find MakeMKV launches as before.

External boot drive

I'd like to occasionally run a Linux operating system on my PC– not from a live disk, but not using any of my limited NVME boot drive's space either. What's the simplest solution?
Peter Fairfax

APC responds: Thanks to the great leap forward brought about by USB 3.0, it's feasible to run Linux (or indeed Windows) from an external SSD drive. USB 3.0 (or USB 3.2 Gen 1) delivers a throughput of 5Gbps, the equivalent of around 500MB/s, which means any external SSD drive will do. However, if you have USB 3.1 (now USB 3.2 Gen 2) ports, you can enjoy double the throughput, in which case choose your drive more carefully to pick one capable of delivering up to 1GB/s throughout, such as Samsung's T7 for even better performance.

Taking Ubuntu as an example, the install process is relatively straightforward to follow, the key thing being you choose 'Something else' under Installation type. This is the most dangerous part so make sure you have correctly identified your USB drive by size and used space (note it won't be dev/sda, which is your Windows drive).

Once identified, select the current NTFS or FAT32 partition and click - to remove it, then click + to create an ext4 journaling partition in its place. Once done, select this newly-created partition and let the installer continue.

Now, whenever you want to boot to Linux, simply override your default boot drive at startup (press F11 to bring up the boot menu) and choose your external SSD drive to boot from it. ■

© Tor

WINDOWS

Reboot Windows 11 File Explorer

Nick Peers shows us how to get much more from this fundamental Windows tool.

YOU'LL NEED
Windows 11 File Explorer plus some optional free apps to give you additional or improved functionality: WizFile, TeraCopy, ViVeTool, Win Subst, and TreeSize Free

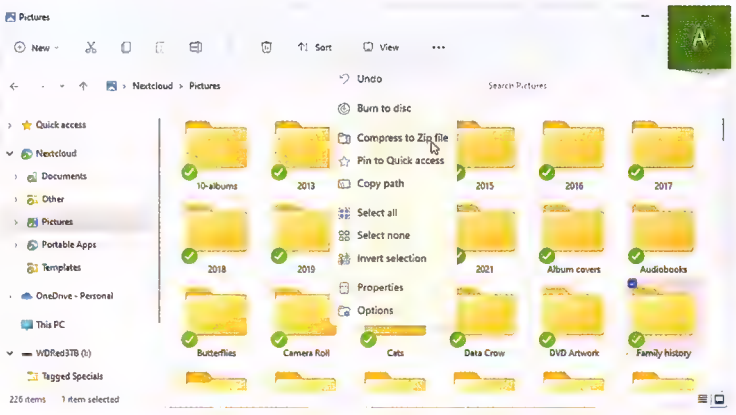
There's no getting away from it: a core part of Windows 11 is File Explorer, the tool used to navigate and manipulate the files and folders on your PC. But for all the time you're using it, are you maximising your use of File Explorer? It has come on leaps and bounds in the last few iterations of Windows, and there may be some hidden features you aren't aware of that could revolutionise the way you interact with your PC's drives.

That's where this latest collection of tips and tricks comes in. We'll start by highlighting some of the lesser-known tools within File Explorer that can help make your life easier. We'll explore third-party tools to fill in some of the gaps or even improve areas of File Explorer further – such as through faster file transfers or by allowing you to map local folders to drive letters for quick and easy access. We'll also give you a sneak peek at what's coming in the next major update as tabs make their long-awaited appearance, and point you towards some alternatives to File Explorer if it fails to meet your file-management needs.

> "One of the most visible changes in Windows 11's File Explorer is the stripped-back ribbon."

A new streamlined ribbon

One of the most visible changes in Windows 11's File Explorer is the stripped-back ribbon. Gone are the tabs of options and tools, replaced by a single row of buttons comprising the most used options, from cutting, copying, and pasting to renaming, deleting, and sharing.

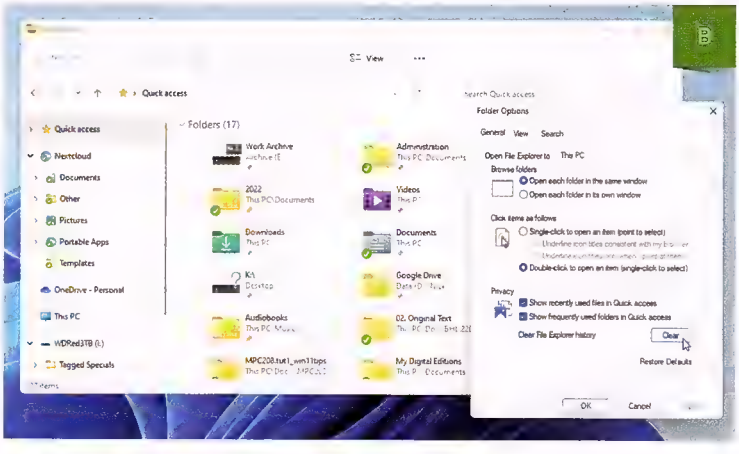


You'll also see that the New, Sort, and View options remain, along with a More (...) button covering useful, but less frequently accessed tools, such as burning discs or mapping and adding network drives [Image A]. Note, the More option is context-sensitive, so its contents will change depending on what you currently have selected.

Compared with the ribbon found in Windows 10's File Explorer, the new version looks rather barren and simplistic. However, all the main features are still here, it's just that some of them are less visible than before. For example, the options to show item checkboxes (to easily select multiple files within a single folder), hidden items, and file extensions are now found under 'View > Show'.

Elsewhere, features removed from the ribbon remain accessible from other locations. For example, the 'Pin to Quick Access' button has gone but you can still drag your chosen folder into the Quick Access menu or right-click it and choose 'Pin to Quick Access' instead.

Similarly, the 'Add Columns' option for choosing what file information to show in the Details view has vanished from the ribbon, but you can simply right-click any of the column headers to reveal the same pop-up menu.



Navigation pane tips and tricks

One of the biggest improvements to File Explorer came with the addition of the left-hand navigation pane in Windows 7. Here, you'll find all manner of shortcuts, and they're due to get a refresh in the next major Windows 11 update, due before the end of the year.

A glance at the Insider Preview reveals that Quick Access has been replaced by a Home shortcut. To all intents and purposes, this is a slightly revamped version of Quick Access with a new, more logical name – see the annotation for details of what to expect. Thankfully, the tips you learn now will continue to apply to Windows 11 once Home makes its appearance.

The navigation pane is home to various shortcuts – Quick Access/Home, This PC, Network, and selected cloud services you may

have installed (including OneDrive). Click > to expand and navigate each in turn. They're largely self-explanatory, but the one that's of most use is Quick Access. Expand this to reveal its mix of any items you've manually pinned to it and frequently accessed folders. Click on Quick Access itself and you'll be whisked to its own folder where you'll also gain easy access to recently opened files.

If you'd prefer to keep Quick Access for personal favorites only, click the More (...) button on the File Explorer command bar and choose Options, then untick either or both file and folder options under Privacy. Alternatively, click Clear to remove the current list while keeping the option active in the future [Image B].

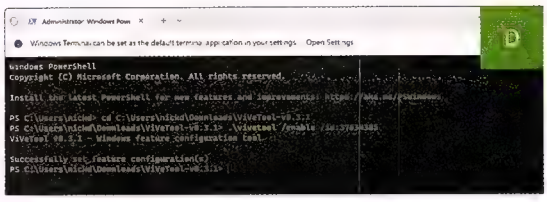
While you're here, switch to the View tab and scroll down to the Navigation pane section where you can, if you wish, disable the Network and This PC view, plus choose to display libraries (depreciated, but clinging on). Choose 'Show all folders' and everything except Quick Access is collapsed into an all-encompassing 'Desktop' view, allowing you to technically access any folder or file from the navigation pane; it does, however, make for a messier view.

Map network folders to drive letters

One way to simplify access to network folders is by assigning them a drive letter – this is particularly handy when the network share doesn't appear as a shortcut under Network. The procedure for doing this hasn't changed – browse to the network folder in question or, if you don't have direct access, type its address into File Explorer's Address Bar like so:

\\DEVICE\pathto\folder

You'll be prompted to supply network credentials if required – you'll need to tick the 'Remember my credentials' box for drive mapping to work. Before doing so, understand that saving your username and password opens the possibility of any ransomware infection on your PC spreading to encrypt files on the network share too. If you don't need read/write access to that share, we strongly recommend adding a user with read-only access to the shared folder and using that to log on; otherwise, make sure the server regularly backs up the shared folder to a secure location to provide you with some mitigation should the worst happen.

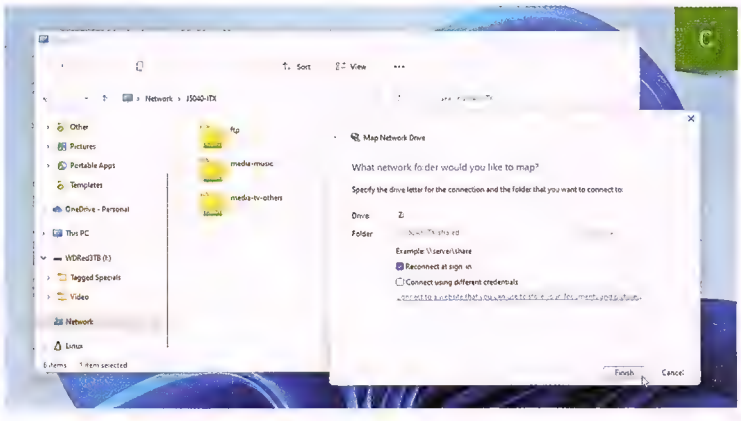


After you're connected, select the folder you wish to map and press Shift-F10 to bypass the new context menu and go straight to the classic right-click menu from where you can select 'Map network drive...' Specify which drive letter you'd like to assign to the shared folder, leave 'Reconnect at sign-in' ticked and click Finish [Image C]. Now you'll be able to jump straight to that folder via This PC – you'll see the drive letter appear under Network drives. To remove the connection permanently, select the drive, press Shift-F10 again, but this time choose Disconnect.

> "Once upon a time, Windows would take forever to search your hard drive for files. Then along came indexed searches with the promise that they would be much quicker. "

Find files on your PC

Once upon a time, Windows would take forever to search your hard drive for files. Then along came indexed searches with the promise that they would be much quicker. Specify which drive letter you'd like to assign to the shared folder, leave 'Reconnect at sign-in' ticked and click Finish [Image C]. Now you'll be able to jump straight to that folder via This PC – you'll see the drive letter appear under Network drives. To remove the connection permanently, select the drive, press Shift-F10 again, but this time choose Disconnect.



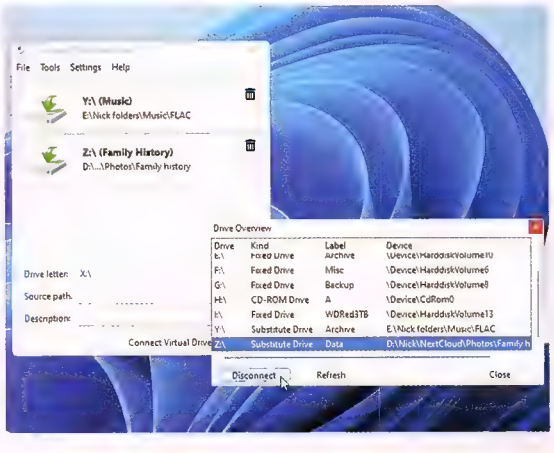
Win Subst makes deeply nested folders easier to access.

MAP LOCAL FOLDERS

Mapping network folders to drive letters is a great way to simplify access to remote shares, but what about being able to map deeply buried folders on your local hard drive too? This functionality doesn't exist within Windows but can be added with a smart portable tool called Win Subst (**www.no-nonsens.nl/win-subst/**).

Once downloaded (note it's 64-bit only) launch Win Subst and click ... next to Source path to define your first folder. Pick a drive letter, add a description, and click Connect Virtual Drive to create a link. One drawback is that it shares the same drive label as its parent drive in File Explorer.

By default, any mapped drives will vanish as soon as you close the program or reboot your PC. You'll find two options under Settings to change this: untick 'Disconnect on Exit' to keep them alive after closing the program, and tick 'Auto Start after logon' to bring them back automatically each time you restart Windows. To back up your folder configuration, choose 'Tools > Export Configuration' and save the .wsub file; the Import option for restoring them is also under Tools. For an overview of all drives, choose 'Tools > Drive Overview'.



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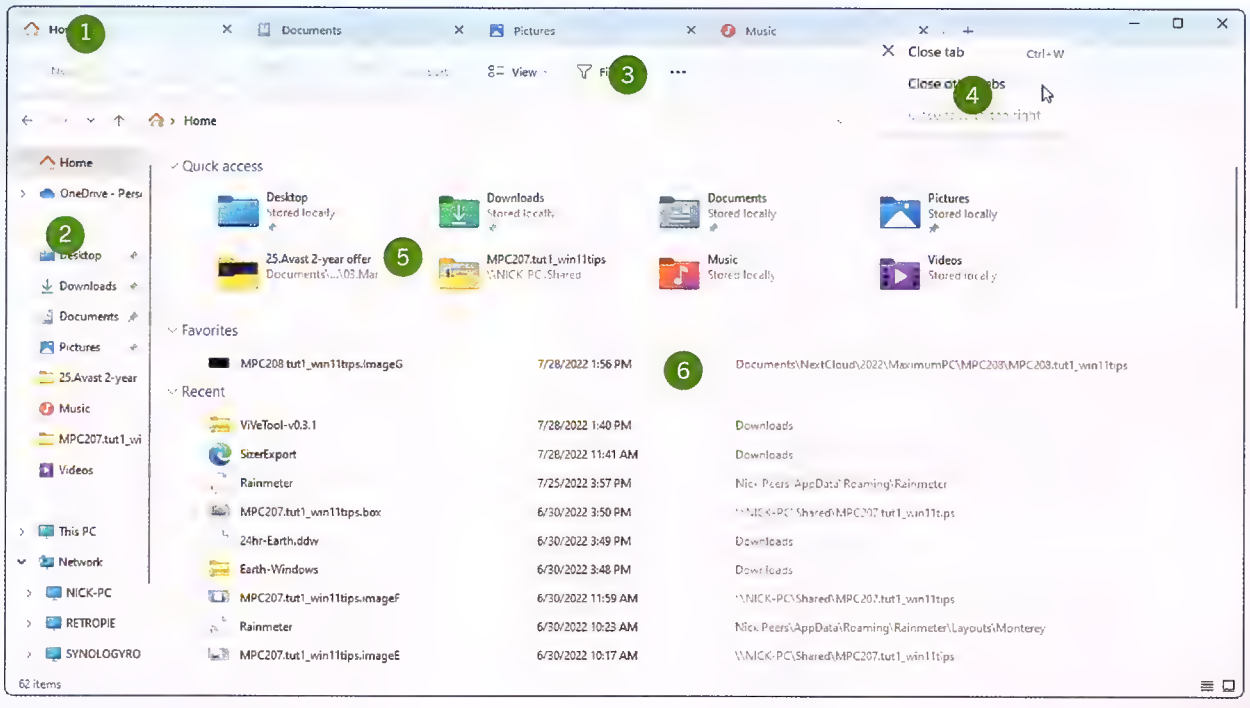


FILE EXPLORER UPGRADE

1. TABS
File Explorer's big new feature is tabbed browsing. Simply drag files and folders onto a tab to copy or move them to that location.

2. NAVIGATION PANE
The pane is now split into three sections and redesigned. Home is a new one-stop shop for favourite files and folders, including Quick Access, which now sits beneath it in the second section.

3. FILTER VIEW
When browsing the Recent list of files in the Home folder, you can now filter this view to show specific file types (Word, Excel, PowerPoint, images, videos, or PDF) using this button.

4. MANAGE TAB BAR
Tabs work in a similar way to the Edge browser – drag and drop to rearrange them, and right-click on the tab for further options.

5. HOME FOLDER
The Home folder is effectively a rebadged Quick Access folder. Click it and you gain access to both favourite and recently accessed folders and files.

6. FAVOURITES
Users can now pin frequently accessed files to the Favourites section of Home. Note these won't show up in the navigation pane, so you'll need to visit the Home folder to access them.

quicker. Indexed searches can also search file content as well as the filename for matches. Access is through File Explorer's search tool, located just below the main command bar.

> "Don't get us wrong, File Explorer's ability to copy and move files has come on leaps and bounds in recent Windows iterations."

Navigate to the top level of your search (such as Documents or a specific drive), type your keyword(s) then hit Enter and the results will be displayed – depending on the speed of the drive and whether you've indexed the location or not, searches can take a few minutes to complete, although results will start to appear almost immediately.

If too many results are returned, you can refine your search from within the tool. Click the 'Search options' menu to reveal options for filtering your search by various criteria: location (including whether to include subfolders), date modified, type, and so on. You'll also see a 'Change indexed locations' option – select this to choose which folders on your hard drive(s) should be indexed in addition to the defaults.

You can also incorporate filters into your search terms – for example, typing apc kind:spreadsheets would only return spreadsheet files containing 'apc' in their filename. You can also search by specific file extensions using the 'type:' operator, such as type:docx or type:png.

Speedy file searches

There are several drawbacks with Windows Search: it's still not instantaneous, even with indexed drives. Windows 11 has dropped support for saving the results of frequently used search terms, forcing you to search from scratch each time.

Thankfully, there's a much faster alternative for simple file or folder name searches: WizFile (**https://antibody-software.com/wizfile/**). WizFile is able to produce complete results within seconds on NTFS-formatted drives because it generates its own file index from the hidden Master File Table (other file systems are also supported, but not as quick to search). The best way to judge whether it works for you is to try it yourself.

After installing (or choosing the portable version), launch WizFile and wait for it to quickly index your drive. Then type a keyword and watch in amazement as results appear in a flash.

By default, WizFile searches for

files and folders. Double-click a file to open it, or right-click for more options, such as opening the parent folder or copying the path to the clipboard. You can search for multiple keywords (just separate each keyword with a space) and perform 'OR' searches using the vertical pipe (|) operator, for example, 'maximum|minimum'.

You'll also see three filters: click 'all types' to search for specific types of files, such as documents or pictures (select 'Options > Filters' to see what file extensions are included for each type of search, plus edit existing filters as well as create your own from scratch). Other filters let you apply file sizes and dates too.

If you'd like to make WizFile more accessible from File Explorer, choose 'Options > Windows Explorer Context Menu' to add WizFile to the classic menu that appears when you select a drive or folder and press Shift-F10.

Faster file transfers

Don't get us wrong, File Explorer's ability to copy and move files has come on leaps and bounds in recent Windows iterations. We especially like the progress bar that allows you to keep an eye on file transfers, complete with pause and cancel options (pause comes in handy when you accidentally start two or three file transfers separately).

Even so, it's still not the quickest way to shunt files around your filesystem. You have a choice of two alternatives here: Teracopy (**www.codesector.com/teracopy**) and FastCopy (**https://fastcopy.jp/**). FastCopy is allegedly quicker, but Teracopy has the advantage of being able to integrate into File Explorer, so it can easily replace the native Windows file copying tool. Instead of choosing between them, why not try both? Install Teracopy for day-to-day transfers, then make use of FastCopy for occasional bulk transfers where its extra speed can make a difference.

Teracopy comes in free and Pro versions, but the Free version has all the functionality you need. Once installed, whenever you drag files from one File Explorer window to another, a pop-up menu will give you the choice of using Explorer or Teracopy – select the latter and you'll see the Teracopy window open with a progress bar and options for pausing, skipping, and stopping. If any file fails to copy due to corruption, Teracopy is smart enough to skip it and move on to the next.

You'll also see check boxes for unattended transfers, which prompt you to choose a default action on file conflicts, such as overwriting older versions automatically, and an option to verify the files after transfer.

By default, Teracopy only provides a progress bar for the current file being processed – click the left-hand button in the toolbar to reveal more information, including a left-hand pane providing details of the overall progress of your transfer in a similar vein to File Explorer. If you miss the File Explorer progress graph, you'll find this under Status.

We've barely scratched the surface of what Teracopy can do, but the key thing is that your files will transfer that bit quicker.

Add tabs to File Explorer

We've mentioned how the upcoming Windows 11 update should unveil a new version of File Explorer with support for tabs, but there's no guarantee that feature will roll out on your PC when the update ships. During the beta program, many users noted how File Explorer implemented some changes (specifically the new Home folder), but not others.

Luckily, you can enable the feature with the help of a third-party tool. Go to **https://github.com/thebookisclosed/ViVe/releases** and download the zip file for the latest version of ViVeTool. Once done, extract its contents, then copy the folder path (such as 'C:\Users\yourname\Downloads\ViVeTool v0.3.1') to the clipboard.

Now right-click the Start button and choose Terminal (Admin). Type cd and right-click to paste the folder path you just copied into the Terminal and hit Enter. Now type the following line:

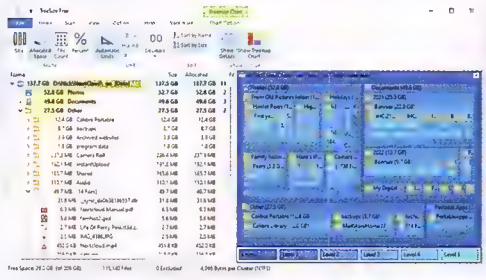
```
.\vivetool /enable /id:37634385
```

Hit Enter [Image D] and reboot your PC – tabs should now be present.

Ditch File Explorer

If File Explorer still doesn't float your boat, you'll find plenty of third-party replacements waiting to take its place. If you like the look of File Explorer, but only need a few additional extras, take a look at Files (**https://files.community/**). It throws in tabs, colour tags to label files and folders for easy identification and filtering, file previews, and a customisable colour scheme for Files [Image E].

If you find yourself frequently returning to multiple sets of folders for different purposes, then Q-Dir (**www.softwareok.com/?seite=Freeware/Q-Dir**) may be a timesaver. It offers a four-paned window, each capable of supporting multiple tabs, so you can create different workspaces for different tasks. Overkill for most people, but it can be run as a portable app, allowing you to switch between it and File Explorer as you see fit. ■

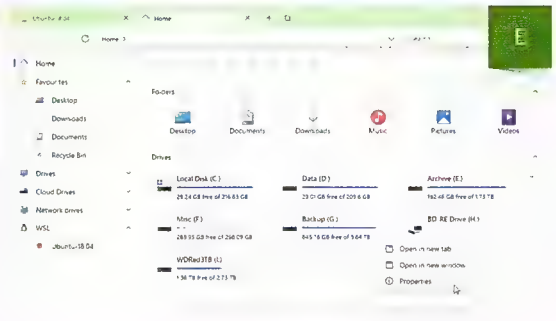


TRACK DRIVE SPACE

While File Explorer's 'This PC' view can give you a basic overview of how much space each drive has free, it can't help you locate which specific files or folders are taking up the most space. You can do this manually, but there are lots of free tools out there that can do the hard work for you.

One such tool is TreeSize Free (**www.jam-software.com/treesize_free**), which quickly scans entire drives or selected directories to provide a visual map of what's taking up all that space. After launching, click the Select Directory button in the ribbon to select a drive or folder to scan. You'll be prompted to restart as an administrator, which is only required if the directory required contains restricted files (if you do so, TreeSize Free will pick up from where it left off – no need to select the folder a second time).

You'll be shown a two-paned window – a tree-like structure on the left and a chart on the right. The chart allows you to navigate between folders but won't show any files within those folders. Use the > button next to a folder in the navigation pane to view its contents.

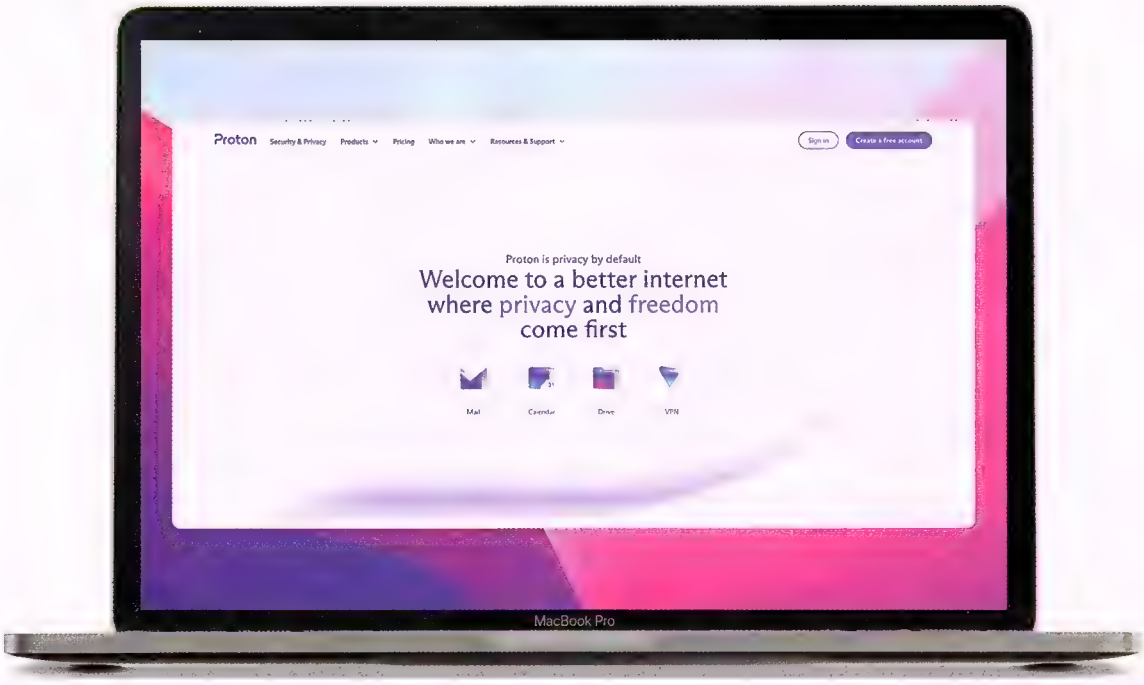


© Microsoft

MAC OS

Secure your emails and more

Proton offers a range of privacy-focused tools, such as encrypted mail.



IT WILL TAKE
60 minutes

YOU WILL LEARN
How to set up a secure and private email account

YOU'LL NEED
A web browser, macOS 10.12 or later

ProtonMail has long been a popular end-to-end encrypted email service. The company behind it has offered other services too, including a Virtual Private Network (VPN). It recently revamped and consolidated its product line, neatly bringing together its Mail, Calendar, Drive (for storage) and VPN tools. Privacy remains the focus throughout, as consumers show ever greater interest in what their data is used for. Proton offers free email accounts, but there are paid upgrades available too. These include an Unlimited package that offers all the services for $229.
Charlotte Henry

"This country and its clever people have contributed much to the technology that has made possible many of the products and services people around the world use today."

HOW TO GET STARTED WITH PROTON

Proton Free

The no-cost starter account designed to empower everyone with privacy by default.

0 € /month

Get Proton for free

1 CREATE AN ACCOUNT

Go to proton.me and tap 'Create a Free Account' in the top right-hand corner. Click 'Get Proton for free' and you can select your @proton.me email address. This will be your login to all the other Proton services.

2 FOLDERS AND LABELS

The free plan enables you to have three folders and three labels. You can create new ones by either clicking the '+' button next to Folders and Labels in the sidebar and adjust them by clicking the gear button below.

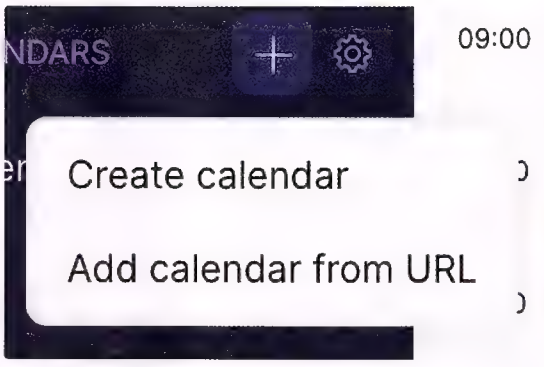
GENIUS TIP!

To move from the web and use Proton Mail in the Mail app, you'll need to download Proton Mail Bridge. This option is only available to paid subscribers.

CONTINUED... GET STARTED WITH PROTON

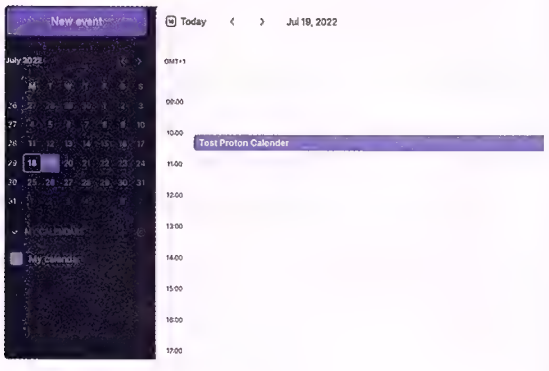
3 PROTON DRIVE BETA

Cloud storage tool Proton Drive is in Beta mode. Once opened, click Enable Beta Access. The service will be familiar to anyone who has used Google Drive. Everything that is uploaded is end-to-end encrypted for privacy.



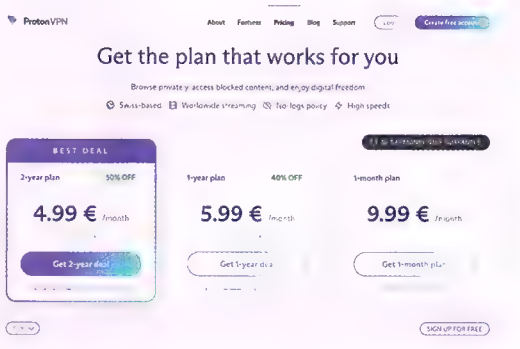
4 SET UP A CALENDAR

Proton Calendar is a straightforward web calendar, not unlike Google Calendar, but with a privacy focus. You can can create new calendars or import existing ones by clicking the '+' button next to My Calendars.



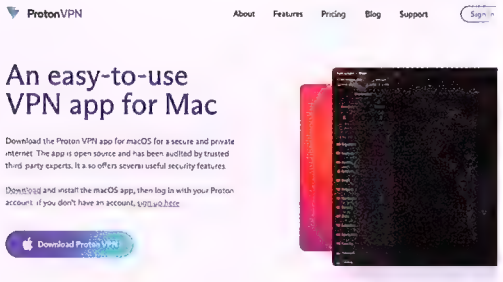
5 GET EVENT REMINDERS

With Proton Calendar all set up up, tap New Event to get something scheduled. Reminders via email and/or web notification can be set at this stage. To edit an event, click on it then click the pencil icon.



6 BROWSE WITH PROTON VPN

Proton VPN can be purchased for €9.99 (about AUD$14) per month or on an annual/two year basis at protonvpn.com. It is included in the general Proton Unlimited plan and a feature-light free version is available too.



7 SETTING UP PROTON VPN

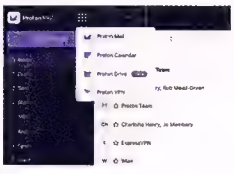
As with all virtual private networks (VPNs), Proton VPN needs some configuring. Download the Mac app and you will be guided through that process, which will require access to your Mac's System Preferences > Security & Privacy pane.

8 TURNING VPN ON

When configured, browse the web privately by opening the Proton VPN app on your Mac, hover over an available location, then click Connect. Clicking Quick Connect will also turn on secure browsing.

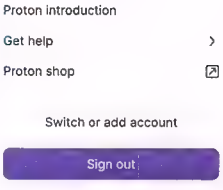
SMALL THINGS

Get the most out of the updated Proton offering...



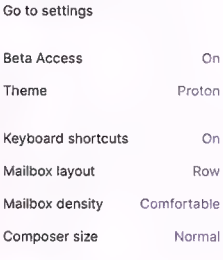
1 SWITCH SERVICES

You can jump between the various different Proton services via a menu opened by clicking the matrix of dots next to a service's name.



2 ADD ACCOUNTS

Add multiple accounts to one Proton inbox by clicking your email address in the top-right corner then click 'Switch or add account'.



3 CHANGE APPEARANCE

You can change the look of your inbox by clicking on Settings in the Proton Mail toolbar and adjusting options such as the layout.

LINUX

Run a modern, focused, alternative to Vim

While Shashank Sharma is quite fond of the text editor Vim, he realises that it can overwhelm new users. Thankfully, a simplified variant is on offer...

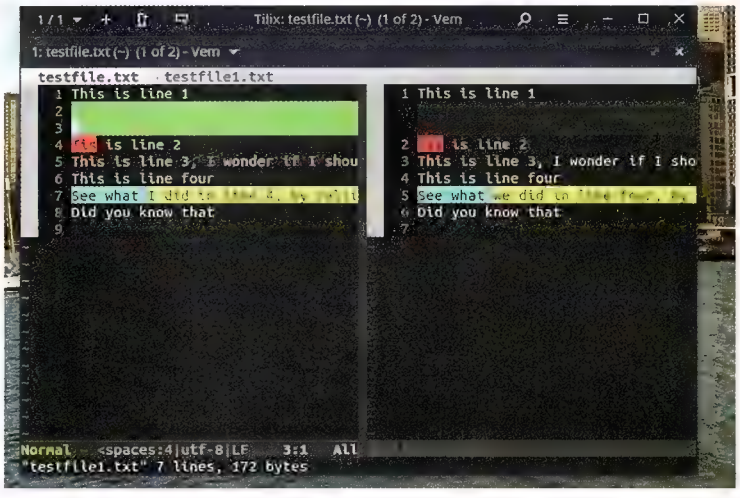
QUICK TIP!
The same key may on occasion be assigned different functions, depending on the mode you're in, so always be aware of the mode you're in currently. The keyboard commands are also case-sensitive, which means pressing W in Normal mode isn't the same as pressing w.

Released over 30 years ago as a derivative of the original *vi* text editor with many additional features thrown in, Vim (a contraction of Vi iMproved) remains one of the most popular text editors even today. Back in the 90s and early noughties, vi vs Emacs, another fiercely popular and feature-rich editor was a hotly debated issue.

Spend a little time on Reddit and you'll know the debate is far from over. Despite its vast feature set, Vim is also awkward for new users to master. Part of this is the reliance on different 'modes' to accommodate its many features and the large set of keyboard commands.

Distributed under the MIT license, Vem is an attempt to scale down some of the functionality of Vim, and simplify the keyboard commands on offer. Instead of being a full-featured text editor, Vem is a set of configuration files for Vim that changes how you interact with the popular text editor. While Vim boasts of hundreds of commands, with their own grammar to control work flow, Vem offers a far simplified editor, with a much smaller set of commands.

Despite using Vim as its base, Vem is distinct enough in its interface and user interaction to be labelled as an editor itself, rather than a skin, or interface


Tilix: testfile.txt (~) (1 of 2) - Vem
1: testfile.txt (~) (1 of 2) - Vem
testfile.txt
testfile1.txt
1 This is line 1
2
3
4 This is line 2
5 This is line 3, I wonder if I shou
6 This is line four
7 See what I did
8 Did you know that
9
1 This is line 1
2 This is line 2
3 This is line 3, I wonder if I sho
4 This is line four
5 See what we did
6 Did you know that
7
Normal <spaces:4|utf-8|LF 3:1 All
"testfile1.txt" 7 lines, 172 bytes

The colour scheme might differ on your machines because it depends on the profile of the terminal emulator.

for Vim. And even though Vem offers a limited feature set, as compared to Vim, it's still more than we can cover in these mere pages. Thankfully, Vem is exceptionally well documented, so you will find a tutorial for quick introduction to the editor, a complete user's guide that covers every aspect of its use, and even cheat sheets that describe all available commands on the website (**www.vem-editor.org/docs/index.html**).

Refer to the Installation box (below) for instructions on how to install Vem. Because Vem is nothing but a simplified version of Vim, you'll find many similarities between the two. To begin, both the editors rely on 'modes' to provide their myriad functionality.

Vem is designed to be used entirely with the keyboard, so it becomes necessary to use different modes to accommodate the different features. Vem starts in the Normal mode by default. You can confirm this from the status line, which shows Normal on the bottom left of the screen. This mode is where you can type commands, and Vem assigns a unique key for each operation. For instance, pressing **s** will save the file, while hitting **x** will exit Vem. If you've launched

FULL-FAT COKE, PLEASE!

Because Vem is only a set of configuration files, you need to have Vim or Neovim installed on your machine, before you install Vem.

Some distributions, such as Ubuntu, ship with a trimmed-down version of Vim, which is appropriately called Vim tiny. For Vem to work, it requires a full-featured Vim or Neovim installation. Thankfully, you can install either using the software repositories, or manually compile them if the version carried in the repositories is much older. At the time of writing, Vim 9 had just been released and wasn't offered in the software repositories of most distributions, so we opted to manually install it before trying out Vem:

```
$ cd ~/Downloads/projects
$ git clone https://github.com/vim/vim.git
$ cd vim
$ cd src
$ make
$ make install
```

The **git clone** command downloads the Vim repository into a **vim** directory. After moving into the **src/** directory, you must run the **make** and **sudo make install** commands to install it.

With this done, we can now deploy Vem on top of our Vim installation:

```
$ cd ~/Downloads/projects
$ git clone https://github.com/pacha/vem.git
$ cd vem
$ sudo make install
```

You can now launch Vem with the **vem <filename>** command. If you've installed Neovim as the base then you must run the **nvem** or **nvem <filename>** command instead.

Vem without specifying a file name, you can open a file browser from the Normal mode by pressing **W**. You can navigate the file browser by using the arrow keys, or even **h** to move to the parent directory, while pressing **k** and **j** moves up or down.

The Insert mode is used when you wish to write some text. You can invoke the Insert mode by pressing either the **i** or **o** keys. You must press **Ctrl-o** or **Esc** key to return to the Normal mode. When with text files, there are a number of operations you might wish to perform, such as moving to the top or bottom of the file, deleting or copying text, moving to the previous or next line or word, and so on. Vem assigns a unique key command for each of these operations, which must be run from the Normal mode.

Next, there's the command mode, which can be used to execute commands such as **:sort** , to sort all lines in the text file, or **:<number>** to move to the specified line in the file.

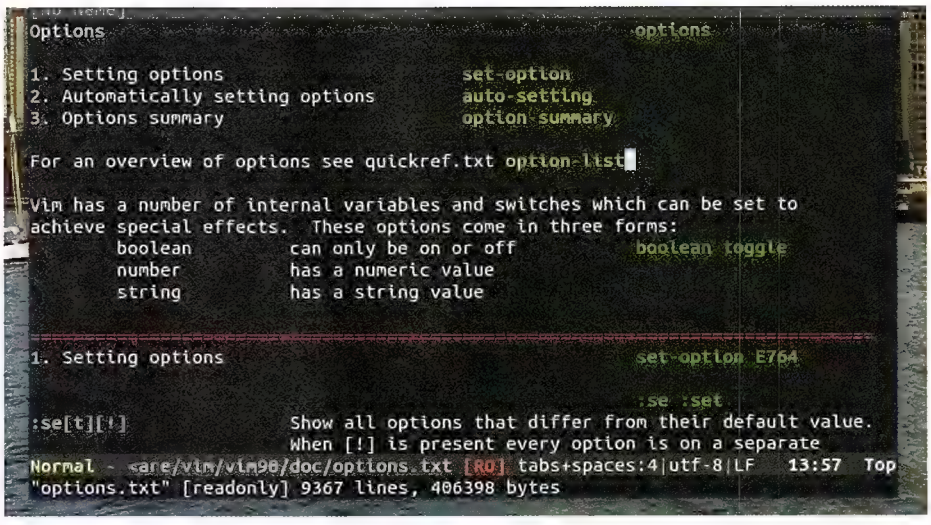
Finally, there's the Visual mode, which is only activated when you've selected a region of text. All operations performed in the Visual mode are applied only to the selected text, and not the entire document.

Working with files

You can open multiple files within the same Vem instance. From the Normal mode, press **W** to open the file manager and select a file. Now repeat the process to select the second file, and Vem will open it in a tab. You can switch between the open files by pressing **t** from the Normal mode.

Instead of browsing through the different directories using the file manager, you can also use the fuzzy finder to quickly locate the file. This is especially useful if you can't remember the location of the file that you're looking for. From the Normal mode, press **Space-w** and then start typing. Vem will recursively look through the directories and display all files that match the entered keys. Either press Enter to open the selected file, or **Ctrl-o** to close the fuzzy finder and return to the Normal mode.

Vem also has a built-in **diff** function so that you can compare two files or more files. This can be done with the **vem -d file1 file2** command, which opens the two specified files side-by-side. Because the editor also supports highlighting, it utilises colours to show the differences between the two files.


Options
options
1. Setting options
set-option
2. Automatically setting options
auto-setting
3. Options summary
option-summary
For an overview of options see quickref.txt option-list
Vim has a number of internal variables and switches which can be set to
achieve special effects. These options come in three forms:
boolean
can only be on or off
boolean toggle
number
has a numeric value
string
has a string value
1. Setting options
set-option E764
:se :set
:se[t][!]
Show all options that differ from their default value.
When [!] is present every option is on a separate
Normal ~ sare/vim/vim90/doc/options.txt [RO] tabs+spaces:4|utf-8|LF 13:57 Top
"options.txt" [readonly] 9367 lines, 406398 bytes

You can get help from within Vem by running the :help command, or even :help <topic> if you know which topic you want more information on, such as set, sort or search.

It's only natural to want to perform an undo/redo operation at times. This is achieved from the Normal mode using the **q** and **Q** keys, respectively.

When selecting text, Vem gives the option to select characterwise, blockwise or linewise. To start selecting, press **G** and start moving the cursor to select text. Press **G** again to switch to a different style of selecting text. You can perform a number of operations on the selected text. For instance, pressing **Ctrl-u** toggles the case of the selected text. You have to select the text again after performing each operation.

The Vem editor also supports spell-checking, but the feature is disabled by default. Run **:set spelllang=xx** , where **xx** is the language two-letter code for your language, such as en for English or es for Spanish, to enable the spell checker. If no language is specified – that is, you simply run the **:set spell** command – the spell checker will default to English.

To enable the spell checker permanently, you must add the command to the **vemrc** file. The **vemrc** file isn't created automatically. But that's quite alright. Open Vem, type **set spell** and save the file as **~/.config/vem/vemrc**. You now need to source this file so that Vem knows to implement the newly defined setting.

So run the **:source ~/.config/vem/vemrc** command from within Vem. You'll now notice your misspelled words are identified automatically by Vem. You can press **Space-y** to move to previous misspelled word, or **Space-n** for the next misspelled word. Press **Space-?** for a list of suggestions to replace the misspelled word. Select the word from the list, and hit **Enter**.

Recommended reading

Unfortunately, that's all we have space to discuss. But there's plenty more that you can do with Vem. While we normally would advise you to just launch the project and play around with it, Vem is the exception. This is because unless you're familiar with some of the basic command operations, such aimless experimenting will only frustrate you.

> "Instead of being a full-featured text editor, Vem is a set of configuration files for Vim that changes how you interact with the popular text editor."

At the very least, run through the tutorial hosted on the project's website (**www.vem-editor.org/docs/tutorial.html**) followed by a quick look at the basic cheat sheet. You'll find a link to it at the bottom of the tutorial. These two pages should provide enough information to help you get started.

When you're ready, launch the user guide from Vem's website, and go through the different sections such as Moving, Selecting, Searching and Substituting to get a sense of the power of this robust text editor. ■

ANALOG ZERO

Get to grips with analog electronic control

Les Pounder "cranks that dial" to relive his youth of soldering irons and 1980s electronics, when a 'bit' was a relatively unknown concept.

YOU'LL NEED THIS

- Any model of Raspberry Pi
- Raspberry Pi OS
- RasPiO Analog Zero
- A breadboard
- An LED
- 10K Ohm potentiometer
- 330 Ohm resistor (orange-orange-orange-gold)
- 3x F2M jumper wires
- 1x M2M jumper wire
- Code **https://github.com/lesp/LXF-Analog-Zero/archive/refs/heads/main.zip**

Electronics are all digital, right? Nope – some electronics components work with analog signals. These signals are continuously running and are typically a variable voltage. Such components include thermistors (a variable resistor whose resistance varies depending on temperature) and photosensors (a variable resistor whose resistance changes depending on light levels).

The most common analog electronic component is the potentiometer. This is a variable resistor that changes resistance based on the user turning a knob. A common potentiometer has a value of 10 Kiloohm (10K) and it can be found in many electronics kits. However, you can't directly wire a potentiometer to a Raspberry Pi. The Pi's GPIO has many pins for digital electronics (and protocols such as I2C, SPI, PWM and I2S), but none of the GPIO pins can be used with analog electronic components. Digital GPIO pins have two states: on and off. Analog components have a variable signal, which could cause issues. So how do we use analog components with a Raspberry Pi? For that we need an ADC, an Analog to Digital Converter.

RasPiO's Analog Zero (**https://rasp.io/analogzero**) is an older add-on for the Raspberry Pi. It was originally created for the Raspberry Pi Zero, but is compatible with all Raspberry Pi. Analog Zero comes as a kit that we need to solder together. In reality Analog Zero is merely a bespoke breakout board for an MCP3008 ADC. We could just use an MCP3008 in a breadboard, but with Analog Zero we get fewer wires and a much tidier build.

In this tutorial we'll use Analog Zero to control the speed at which an LED blinks, and its brightness.

> "In this tutorial we'll use Analog Zero to control the speed at which an LED blinks, and its brightness."

Hardware setup

Analog Zero comes as a kit, so you will need to spend a little time soldering it together. With the kit built, check all of the solder joints to ensure that no two joints are joined by a blob of solder (this is called a solder bridge). If they are, just use the soldering iron to remelt the solder.

To wire up the test circuit we need to insert a 10 Kilo Ohm potentiometer into a breadboard, so that the knob faces away from the breadboard. Looking face-on at the potentiometer, there are three pins. The left pin connects to GND on Analog Zero, the right pin to 3.3V. The centre pin connects to A0 on Analog Zero.

Using jumper wires, the long leg (Anode) of our LED connects to GP17 and the short leg (Cathode) connects to GND via a 330 Ohm resistor. See the detailed circuit diagram in the GitHub download for this project.

With the Raspberry Pi powered off, place Analog Zero on to the GPIO so that it connects to every pin and that it fits on top of the Pi. Connect your keyboard, mouse, screen and finally power up the Pi to the desktop.

Software setup

Raspberry Pi OS already comes with all the software that we need. But we do need to enable the SPI interface because Analog Zero uses this to communicate with the MCP3008 chip.

Open a terminal and use **raspi-config** :

```
$ sudo raspi-config
```

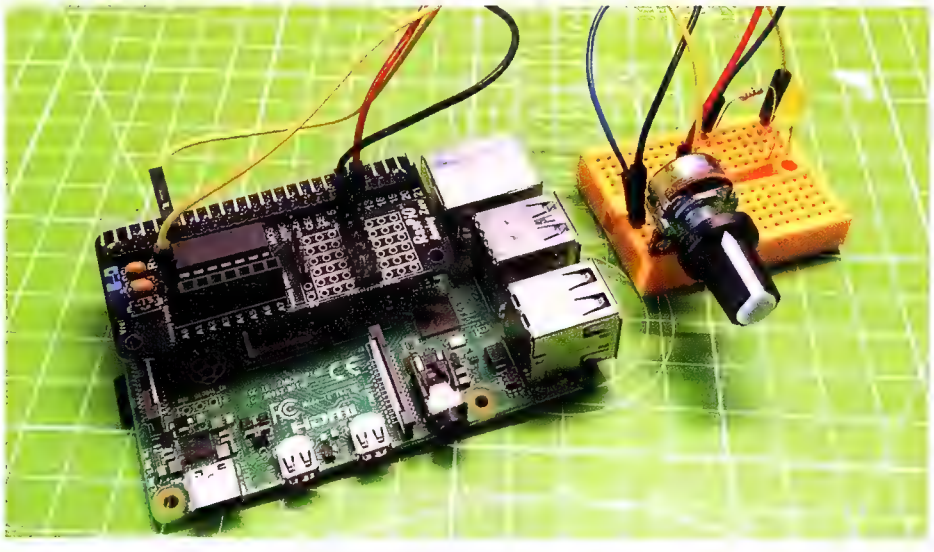
Scroll down to Interface Options and press Enter. In the next screen scroll down to SPI and press Enter. Select Yes to enable the SPI interface, then press Enter to OK. From the main menu select Finish and press Enter to exit. SPI is now enabled.

We'll be using Python to work with Analog Zero – the GPIOZero library, which has a special class to work with MCP3008 ADC. Open the Thonny Python IDE to start coding. We start the code by importing two classes from GPIOZero. The first is MCP3008 (Analog Zero's ADC) and the second is LED. We'll also import the sleep function from the time module.

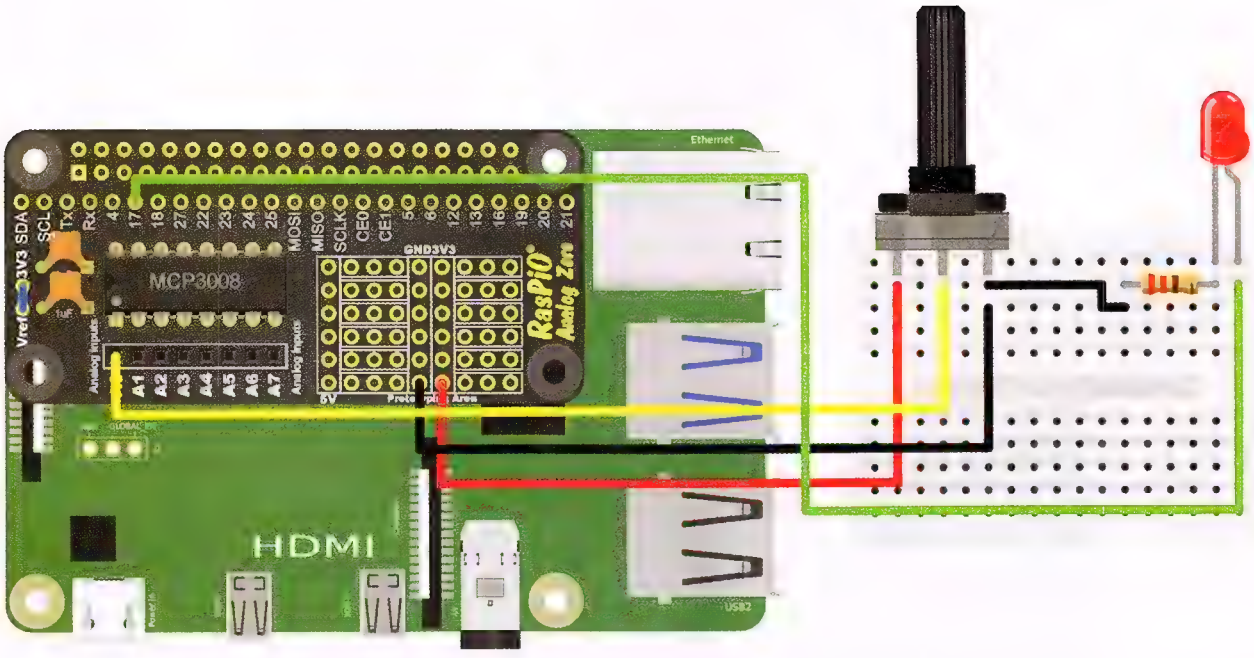
```
from gpiozero import MCP3008, LED
from time import sleep
```

Next we tell Python where to find our 10K potentiometer, channel 0 of Analog Zero. This is stored into an object called **pot** for easy reference. The **led** object tells Python that our LED is on GPIO17.

```
pot = MCP3008(channel=0)
```



The completed circuit is simple on purpose, to ensure that we understand how to build circuits using analog and digital components.



All of our connections are made via Analog Zero. GPIO pins are broken out on the top row of the board, while analog pins are bottom left.

```
led = LED(17)
```

Next, create a loop that will run the example code indefinitely:

```
while True:
```

The value returned from reading the potentiometer is between 0 and 1. We don't need this level of precision, so we use **round()** to round the values to one decimal place. The value is then stored in the **blink** variable. This variable is updated each time the loop iterates.

```
    blink = round(pot.value,1)
```

A debug line, we print the value stored in the **blink** variable. This isn't essential, but it's useful to see that the value is being read when debugging any issues.

```
    print(blink)
```

GPIOZero's LED class has a special method to control the state of an LED. The **toggle** method swaps the state of the LED, so on becomes off and off, on. We use this to turn the LED on/off.

```
    led.toggle()
```

To control the duration that the LED is on/off we use **sleep**. By multiplying the value stored in **blink** by five we can create a useful pause that'll keep an LED lit and unlit for the same duration.

```
    sleep(blink*5)
```

Save the code as **LED-Blink** and click Run. Next, save the code as **Potentiometer-Blnk.py**. Now turn the potentiometer to change the duration of the blink.

Adjust the brightness

So we've used the analog value to control the speed at which an LED can blink, but how can we use it to control the brightness? To do this we need to use PWM, Pulse Width Modulation, which will rapidly turn an LED on and off to approximate a brightness level. We'll reuse the circuit from the previous project.

Create a new file and import the PWMLED and MCP3008 classes from GPIOZero.

```
from gpiozero import PWMLED, MCP3008
```

Import the sleep function **from time**.

```
from time import sleep
```

Create connections to channel 0 of the MCP3008 (where our potentiometer is connected) and to GPIO17. This time the **led** object uses **PWMLED** so that we can control its brightness.

```
pot = MCP3008(channel=0)
led = PWMLED(17)
```

Create a loop to run the code.

```
while True:
```

Create an object – **brightness** – to store the value returned by the potentiometer. Again, we round this to return a value with one decimal place that's much easier for **PWMLED** to work with:

```
    brightness = round(pot.value,1)
```

Again we use a **print** function to print the brightness value to the Python shell.

```
    print(brightness)
```

We then set the brightness of the LED to match the value stored in the **brightness** object.

```
    led.value = brightness
```

Finally we add a short 0.1 second pause to the loop, which is enough to keep the LED brightness changes smooth, and clearly visible.

```
    sleep(0.1)
```

Save the code as **LED-Fading.py** and click Run to start. Now turn the potentiometer to set the brightness of the LED. ■

GENIUS TIP!

The position of 3V3 and GND can be swapped on the potentiometer so that turning up the dial increases the resistance, effectively shortening the delay and decreasing the LED brightness.

CIRCUITPYTHON AND THE PT PICO

The global chip shortage continues to cause supply problems in both the Raspberry Pi and larger electronics community. Sometimes our favourite chips are out of stock, or priced far too high. The Raspberry Pi Pico, Raspberry Pi's own microcontroller, appears to be largely unaffected. Not immune to the shortage is the MCP3008 as used in Analog Zero. So what can we use if we don't have an MCP3008? We can use the MCP3208, and GPIOZero has a class for just this chip. We can also use a Raspberry Pi Pico!

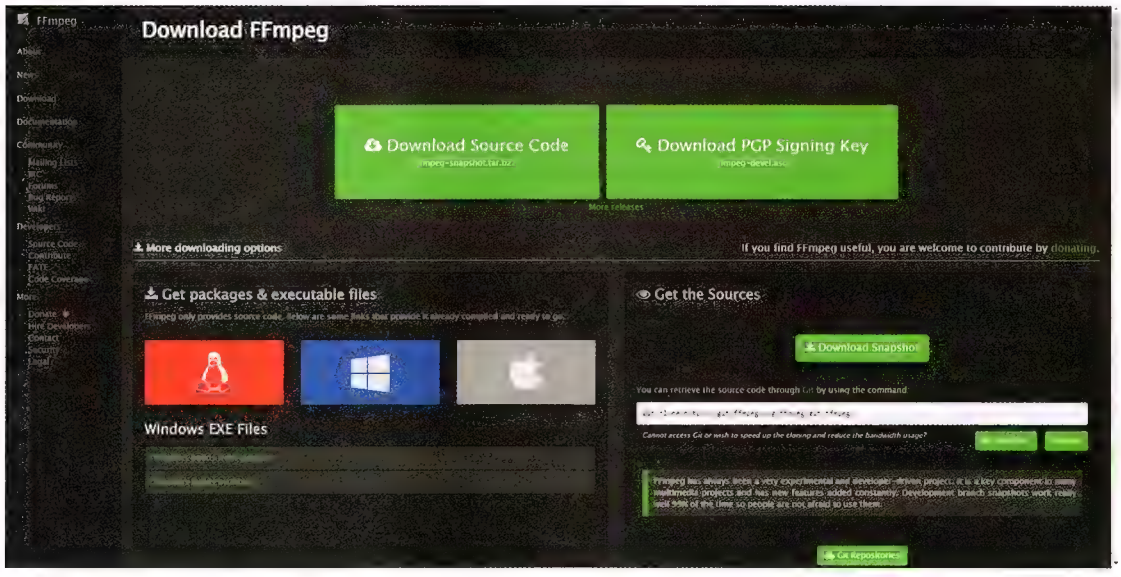
Using the latest version of CircuitPython, we wrote a simple script based on Adafruit's excellent examples. By default, CircuitPython will output text to the Python shell, which we can read over a USB serial interface. Using the PySerial library on our Raspberry Pi we ported our LED Fading example to use the Pico as a makeshift ADC. Not bad and we also get a rather powerful microcontroller for free. You can use a Raspberry Pi Pico, Arduino, micro:bit or any other microcontroller with the potentiometer. As long as it can send data over serial (most can) then you're good to go.

We've included the code in the download for this tutorial.

MULTIMEDIA

Codec wars: the battle for next-generation streaming

Open-source, royalty-free and 30 percent leaner than HEVC, a new video codec is playing on a streaming service near you – and it won't be the only option. Is this 'Beta vs VHS' again? Darren Yates explains.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The latest version of the FFmpeg toolkit supports AV1 encoding.

Video compression doesn't seem to create the same excitement as cryptocurrencies and artificial intelligence, but it's safe to say that without it, there'd be no streaming services and no binge-watching *House of the Dragon*. We've come a long way from the days of MPEG-2 compression on DVDs, but the latest video compression-decompression or 'codec' formats to hit the airwaves are quietly creating a new scramble amongst streaming services and device manufacturers alike.

The new AV1 codec claims to be as good as HEVC while using 30 percent less data.

Video what?

If you're watching your big 4K TV, you're probably looking at 3,840 x 2,160 picture elements or 'pixels', each one capable of showing at least 16.7 million colours. Those colours come about by varying the proportions of the three primary subpixel colours – red, green and blue (RGB). Each primary colour requires at least one byte of data, so that's three bytes per pixel. Multiply that by 3,840 x 2,160-pixels and you've got nearly 8.3 million pixels x three-bytes, or 24.8MB of data – and that's just for one frame. Multiply that by 25 frames per second and you're looking at 622MB of data every second. At that rate, a 1TB hard drive holds a bit under 27 minutes of video.

This is where video compression comes in – it's the science of maintaining the original video quality whilst dropping the streaming data rate (and hence, the storage costs) as low as you can.

New codecs on the block

For years, video streaming has relied on various versions of MPEG-4 and HEVC/H.265. But as TVs – and their pixel resolutions – continue to grow, more and more data is required to maintain the same high-quality image. With streaming services racking up bills globally for video storage, it's not surprising there's continual research in codec development aiming to reduce the amount of data required. Right now, with glimpses of the 1980s 'Beta vs VHS' war, the race is heating up between two new codec combatants both claiming to leave HEVC behind – they're known as AV1 and VVC.

Open-source AV1

In one corner, AV1 is the production version of the 'Scalable Video Technology for AV1' (SVT-AV1) codec created by Intel and Netflix back in 2019. But what makes AV1 different is that it's an industry-supported open-source, royalty-free codec sponsored by the Alliance for Open Media (AOMedia). You might not recognise that name, but you'll recognise its members, which include – ahem – Samsung, LG, Microsoft, Netflix, Mozilla, Nvidia, Intel, Google, AMD, Facebook, ARM, Amazon, Apple and quite a few others.

One of AV1's key claims is its ability to offer the same image quality as H.265/HEVC, but with 30 percent less data – and it has streaming services already sitting up and taking notice.

In late-July 2022, Netflix began streaming AV1 content to compatible TVs and games

consoles. Android mobile device makers have had the option of including an AV1 decoder since Android 10 and Google made it mandatory for new Google TV devices starting April 2021. Many 2020-or-later LG and Samsung TVs also already support AV1.

As for browsers, Firefox now includes hardware-accelerated AV1 support as of Firefox 100 and Chrome has had AV1 back to Chrome 70. Word is YouTube has also begun encoding its videos to AV1. If streaming services can save 30 percent of their cloud storage costs via AV1, it's not a hard-sell. Throw in its royalty-free status and you can see why media and streaming services are on-board.

Versatile Video Coding

In the other corner, VVC (versatile video coding)/H.266 is the up-coming successor for H.265/HEVC developed by the Joint Video Experts Team (JVET). Moreover, VVC has some big-name backers, including Microsoft, Apple, Sony and Intel. Like its predecessors, it's a licensed codec, although, Fraunhofer-HHI (the team behind MP3 audio) has also created open-source encoder (VVenC) and decoder (VVdeC) versions. But where VVC excels is its claim to deliver a 50 percent reduction in video data compared with HEVC on 4K video, putting it ahead of AV1 in the efficiency stakes.

Back in 2019, the BBC's research and development group put the two codecs head-to-head in what they described as a 'non-exhaustive' test. At the time, they rated VVC as offering a 35 percent data reduction against AV1 on ultra-HD content. The drawback was VVC had a notably slower encoding speed (**http://tinyurl.com/apc512bbc**), but it's common for speeds to improve as codecs develop.

Current issues

Nevertheless, the Achilles' heel for many new codecs is the less data you use, the more complex the codec is and the more CPU processing power you need – and both AV1 and VVC are no exceptions. Encoding speed is also dependent on the video frame size (the number of pixels) and as we found, encoding even just Full-HD video with AV1 seems no lightweight task.

Above: It's looking likely VVC will supersede H.265 on future generations of iPhone.
Left: Many of Samsung's TVs, including the QN95A, already support AV1 video.

At time of writing, no browser supported VVC and no streaming service had begun using the codec. However, with Apple using H.265 in iOS devices, it's very likely VVC will become its replacement.

Currently, no TVs natively support VVC, although that will change soon with chipmaker MediaTek recently launching the Pentonic 700 SoC (System-on-a-Chip) for 4K TVs with AV1 and VVC support, along with the previously-announced Pentonic 2000 SoC for 8K TVs. In Europe, the Digital Video Broadcasting (DVB) project has added VVC to its broadcast specifications, an indication of where things may eventually head for TV streaming in Australia.

Where to find AV1 and VVC

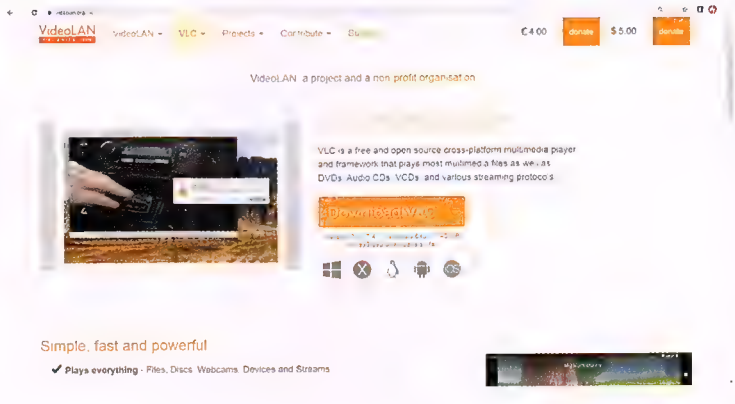
AV1 is the easier to find at the moment – our go-to video player, VLC Media Player, features the 'dav1d' AV1 decoder, so have at least VLC version 3.0.17 and you should be good to go. At time of writing, VVC wasn't officially supported, but a VVC decoder plug-in for VLC can be found on GitHub.

If you're interested in creating AV1 content, that Swiss army-knife of video encoding – FFmpeg – supports both SVT-AV1 and libaom-AV1 codecs. You'll find pre-compiled binaries for Windows and Linux (plus source code) on **http://ffmpeg.org**. However, we found the default settings for libaom-AV1 comparatively slow, even on a quad-core Core i5 box, so learning the codec's tweaks is advised.

If you're looking for AV1 or VVC clips to play, YouTube has a short AV1 playlist from the beta launch in 2018 at **http://tinyurl.com/apc512av1**.

What you need to do now

We see VVC as roughly 18 months behind AV1 in its roll-out, so there's nothing to do here yet, but if you have the latest Chrome or Firefox browser and you're running VLC 3.0.17 or later, you should have AV1 playback covered. AV2, the successor to AV1, is already on the drawing board, so if nothing else, expect the streaming video landscape to continue to evolve. But if you are thinking of buying a new 8K TV, I'd consider waiting until you can be sure of getting both AV1 and VVC support. ■


VideoLAN
VLC
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VideoLAN, a project and a non-profit organisation
VLC is a free and open source cross-platform multimedia player and framework that plays most multimedia files as well as DVDs, Audio CDs, VCDs, and various streaming protocols
Download VLC
Simple, fast and powerful
Plays everything - Files, Discs, Webcams, Devices and Streams

VVC

Above: VVC claims to need only half the data to match its H.265 codec predecessor.
Left: Grab VLC version 3.0.17 or later and you have AV1 playback covered.

DOWNTIME

LEARNING ABOUT OLD MACHINES AND BRINGING THEM BACK TO LIFE VIRTUALLY

MACHINE OF THE MONTH

Tandy TRS-80 (1977)

John Knight on one of the most popular early computers of them all.

In this installment of this series, we are covering the third machine in the 'Holy Trinity' of microcomputers launched in 1977. Tandy/Radio Shack's TRS-80 was the plucky underdog of the trio but played a big part in helping to establish home computing. Pitched against rivals from Commodore and Apple, the TRS-80 was the cheapest option of the three, bringing computing to the masses long before Commodore would seize the lower market.

For those willing to dive in, the TRS-80 has a large gaming library with plenty of classic titles. However, emulating the platform can be tricky, so, after a brief history lesson on the machine, let us guide you through the process.

■ **CPU:** Zilog Z80 @ 1.78MHz **ROM:** 12KB **RAM:** 4-48KB **Graphics:** Monochrome text, 16 lines x 64 characters; 48 x 128 graphical 'square dots' **Storage:** Cassette, 5.25-inch floppy, hard disk **OS:** Microsoft BASIC (ROM), TRSDOS, LDOS, NewDos/80, CP/M **Released:** August 1977 **Production:** 1977-1981, 1991 (Model 4).

Development

Tandy's first foray into the computer market was based on the new Zilog Z80 processor, clocked at 1.78MHz. Early models shipped with 4KB of RAM. Graphically, the TRS-80 was monochrome, with a sophisticated 64-column text mode. However, to save a few dollars, standard units only shipped with uppercase letters, with lowercase support available with a ROM upgrade. The TRS-80's graphics mode is primitive and chunky, using a field of 128x48 'square dots'.

Tandy's default monitor was a 12-inch black and white TV with minor modifications. The TRS-80 didn't have a speaker, but basic square wave tones could be sent through the cassette port.

Three levels of BASIC were available: Level I, a simple 4KB variant; Level II, a 12KB Microsoft-licensed version with double-precision floating point operations; and Level III, a tape-based version of Extended BASIC with Tandy Enhancements.

The TRS-80 was launched on 3rd August 1977, at around $399 for the computer alone or $599 for a base package, including a tape drive and monitor.

Although the price was low, its options list was large and costly. Using a floppy drive required an expansion interface, and upgraded RAM or BASIC was expensive. An "Engineer" 16K package with Level II BASIC cost $1,457, and a "Deluxe Business" 32K cost an eye-watering $4,191.

Software

Although the TRS-80 had business titles like Visicalc (1980) and Electric Pencil (1979), it was more popular in education and gaming. Gaming-wise, we were spoiled for choice with the TRS-80's extensive library. If you don't mind chunky monochrome graphics, you can expect surprisingly ambitious gaming, often fast-paced, with a crunchy soundtrack.

For some personal favourites, *Crazy Painter* (1982) is a highly original concept with frantic arcade action; *Olympic Decathlon* (1980) is a keyboard-thrashing sports game from Microsoft with some beautiful animations; and for some cool voice synthesis, try frenzied space shooter *Defense Command* (1982).

If you fancy some first-person/semi-3D action, some impressive titles are *13 Ghosts* (1982), a unique shooting gallery style game; tank shooter *Armored Patrol* (1981); "3D" space shooter *Stellar Escort* (1980); and *T80-FS1 Flight Simulator* (1980), which switches between cockpit view and bird's eye view.

There are plenty of clone games, we liked *Galaxian* clone *Galaxy Invasion* (1980); *Penetrator* (1982), a *Scramble* clone that is probably better known than the original; *Defender* clone *Eliminator* (1981); and *Scarfman* (1981), a *Pacman* clone.

A good software archive exists at **www.classic-computers.org.nz**, under DS System 80 -> Software, however, any TRS-80 fan should seriously check out the information and resources available at **trs-80.com** and **cpmarchives.classiccmp.org/trs80.php**.

Above: Tandy's default monitor was a 12-inch black and white TV with modifications. Basic tones could be sent through the cassette port.

YOU'LL NEED THIS

A copy of TRS80gp
Windows, Linux, and Mac OS are supported System ROMs and boot software are supplied.
http://48k.ca/trs80gp.html

© wikipedia

Reception and legacy

Tandy planned to make a few thousand units – unsold stock could be used for Radio Shack inventory. However, demand was overwhelming, and by 1980, Tandy had sold three times as many units as Apple.

In 1978, Tandy introduced a 5.25in floppy drive with an 85KB formatted capacity on single density disks.

In October 1979, Tandy released a business-oriented follow-up, the Model II. This was incompatible with the original TRS-80, which was back-named the Model I.

In July 1980, Tandy released the Model III, which was claimed to be 80 percent backward-compatible with the Model I. These included lowercase characters as standard, a better keyboard, faster processor, faster tape access, 48KB maximum RAM capacity, and 180KB double-density single-sided disk storage. The Model III was popular in schools where its all-in-one case used fewer cables and made it harder to steal components.

In April 1983, Tandy released the TRS-80 Model 4. This was backward-compatible with the Model III and sported a faster 4 MHz Z80A CPU, 80 column text, 64KB of RAM (upgradeable to 128KB), and 640x240 graphics.

The TRS-80 line spawned numerous clones, including EACA's Video Genie in Hong Kong, and the Dick Smith System 80 line in Australia. The TRS-80 name was applied to unrelated products, such as the Model 100 and Pocket Computer, as well as the Color Computer series. When Tandy discontinued the line in 1991, it had sold around 2.4 million units.

Emulation

Many emulators are available, but TRS80gp comes with system ROMs and supports Windows, Linux, and Mac.

Head to the website and download the ZIP file – the link is at the top of the page. Extract the ZIP file – inside it are multiple folders for different platforms. Under the windows folder is a standalone executable file, trs80gp.exe. Double-click to run it.

Under the linux-32 and linux-64 folders are also standalone executables, titled trs80gp. Depending on your distro, you may be able to run these files simply by clicking on them. Otherwise, open a terminal within the folder and enter the command:

```
$ ./trs80gp
```

The application starts a Model III by default, booting up a TRSDOS prompt. You can explore different machines under File > Change Model. Most software is for the Model I and Model III.

Loading software

Most software online comes as disk images, but tapes can be loaded by dragging and dropping the cassette file onto the emulator window. For loading disks, see if the game has an autoboot function. If not, you have to manually enter commands.

To load a bootable disk, start with Drive 0, by clicking Diskette > :0 << (name of disk) >> > Replace. Select your disk image from the file browser and click Open. Now restart the emulated machine by clicking File > Reset Button, or pressing Alt-F5.

If your program hasn't loaded but you find yourself at a DOS prompt, some games need to be in Drive 0 but still loaded manually. At the prompt, type:

```
DIR
```

This will give you a file listing. Unlike modern computers, the TRS-80 uses a forward slash instead of a period for separating file names from extensions. The extensions to look out for are CMD and BAS: CMD files are binary programs, BAS files are BASIC programs.

To use *Zork*'s disk as an example, it lists two files:

```
ZORK/DAT    ZORK/CMD
```

To run the CMD file, enter the file name by itself:

```
ZORK
```

Running BASIC programs is harder, as you have to invoke BASIC. To use *Gammon* as an example, which has the file name GAMMON/BAS, enter the following command, changing the file name between the quotes:

```
BASIC RUN "GAMMON/BAS"
```

It still doesn't work!

If you received a "NO SYS" error or had a black screen, you will have to load things the hard way.

We recommend switching from TRSDOS, which is loaded by default, to LDOS which has much better compatibility. Note that system disks, like TRSDOS or LDOS, need to be in drive 0; whereas data disks, such as games, can be used in drives 1, 2, and 3.

Change the boot disk by clicking Diskette > 0: <<TRSDOS13.dmk>> > Eject. (Model I is labeled TRSDOS23.dmk). When you open the Diskette menu, the Drive 0 menu labeled "0:" will display as empty.

Open the Drive 0 menu and select LDOS. It can be difficult to spot, but for the Model I it will be called ld351-1.dsk and for the Model III it will be called ld3-531.dsk.

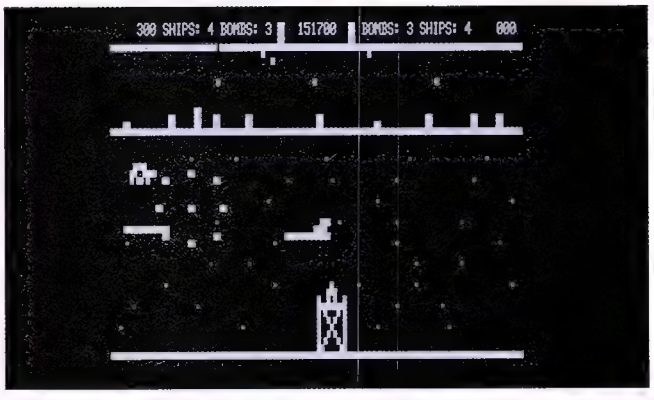
Now reset the emulated machine by clicking File > Reset Button, or pressing Alt-F5.

With LDOS now loaded, insert your program disk into Drive 1 by clicking Diskette > :1 <empty> > Insert disk, then choose your file. Browse Drive 1 by entering:

```
DIR :1
```

Now you can load files the same way as above with our *Zork* and *Gammon* examples – no drive numbers need to be entered, the TRS-80 will find the file regardless of which drive it's on.

Finally, if a game asks you to press the Clear button, this is mapped to Home on a modern keyboard. ■



Top: Although there are plenty of standard text adventures, titles such as *Asylum* (1981) integrate early graphics and additional gameplay elements.
Above: TRS-80 games, such as *Eliminator*, really punch above their weight, with cool voice synthesis, attractive text, industrial sound, and frenetic gameplay.

© © Williams Electronics, Med Systems Software

GAMES

MultiVersus

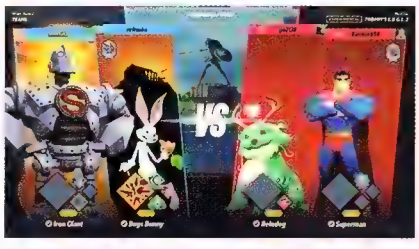
An unexpectedly great matchup – even if it does whiff a few attacks.

■ Free or $59 | PC, PS4/5, XBS/X | multiversus.com

I'm *Adventure Time*'s Jake the Dog, standing on the edge of a *Rick and Morty*-themed arena. I'm about to beat Shaggy from *Scooby-Doo* into a bloody pulp while my teammate Arya Stark is casually stealing Batman's face. A few years ago this would have given me severe whiplash, but in a world where tennis star Naomi Osaka is throwing hands at Naruto in *Fortnite*, nothing surprises me any more.

MultiVersus' biggest inspiration is still clear. Anyone who has spent a modicum of time with Nintendo's *Smash Bros* will quickly get the gist: smack your opponent with a mixture of normal, air, and special attacks in order to increase their damage meter; avoid letting them do the same to you. Victory has nothing to do with getting a health bar from 100 to 0, it's all done through the damage meter. While the number is low, you're weighty and difficult to knock off the top and sides of the arena. As it gets higher though, your character turns into a rubber bouncy ball, and becomes susceptible to all kinds of spikes and knockback attacks that can fling you straight into the death zone. Knock your opponent out of the arena enough times and you'll claim victory.

It's your standard platform fighter formula at this point, but *MultiVersus* manages a few key differences that really set it apart. The first one is how the game handles its roster. Every character belongs to a class: tank, support, mage, bruiser, and assassin. Tanks like Wonder Woman and Iron Giant can take more hits and are harder to ring out but are slower. Assassins like Finn the Human and Arya Stark are nimble fighters, dealing big damage quickly.



What's nice is there doesn't feel like any pressure to match up particular classes – you can easily run a team of two supports and successfully outmatch bruisers and tanks if you have the skill. They're a great initial indicator of how you can expect to play each character, but it doesn't feel like any one class is at an inherent disadvantage compared to the others.

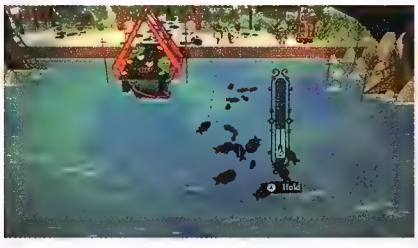
There are also the game modes themselves. While other platformers feel more at home in a free-for-all or 1v1 setting, *MultiVersus* thrives off a 2v2 format. The other two modes are present in the game, but this game was absolutely made for 2v2 and it's where I spent most of my time. Every character has abilities that can support teammates as well as harm foes.

As it stands, *MultiVersus* has done a good job of laying the foundations for a fantastic platform fighter that has the potential to blossom into something amazing. Killer backpacks and janky hitboxes aside, each character is brimming with personality and movesets that never feel too out-of-character.

A fun *Smash Bros* on PC that needs a little more fine-tuning to reach its full potential.

Mollie Taylor

★★★★☆



Thejuljul
Benevolent Leader, please don't judge me, but...
I've always wanted to eat a meal made of poop.
Will you help me satisfy this dark desire?

CULT OF THE LAMB

It feels good being baaad.

■ $35.95 | PC, PS4/5, Switch, XB1/S/X | cultofthelamb.com

Things start with you, as a cowering little lamb, being led to your death as a sacrifice. Within ten minutes however, you've already exacted violent revenge on your would-be murderers and pledged your adorable allegiance to the mysterious being that returned you to the land of the living. You start a cult of your own; a cult where all the members are super-cute creatures.

This is *Animal Crossing* if Tom Nook craved power instead of money. The first half of the game involves growing, caring for, and – of course – indoctrinating your cult. You'll need to take care of the basics before getting too ambitious, though. Your adorable little cultists need food to eat, places to sleep, and somewhere to poop.

The fundamental idea is that the bigger and happier your cult is, the faster you can harvest their Devotion, which works as XP. This in turn either directly or indirectly unlocks weapons, perks and abilities for the dungeons, and blueprints for decoration and functional buildings for your cult. Part of the progression system involves developing your cult's doctrine. While this is a binary either/or choice each time, it's still an enjoyable way to decide how reasonable/evil you want to be while gaining a new perk in the process. For example, I wanted to make sure that my followers respected the elderly, resulting in a faith boost whenever I had a member reach a certain age. That more than makes up for the cannibalism thing, right?

> "This is *Animal Crossing* if Tom Nook craved power instead of money."

Cult of the Lamb is wonderfully designed, and the script is sharp and funny. The atmosphere is great, helped in no small part by art which immediately endears itself to you. Speaking of which, making all of your followers adorable wickle critters was a smart choice. Intentionally or otherwise, it makes the brainwashing and murky morals amusing rather than disturbing.

Don't be fooled into thinking that this game is anything but great, though. I adore it, and that is almost certainly my own opinion unaffected by nefarious influences.

Unlike anything else in a good way, you won't feel fleeced if you buy this. Ha ha! 'Fleeced...'

Luke Kemp

★★★★☆

DE TRES AL CUARTO

Everyone's a comedian in this stand-up adventure game.

■ Free | PC | bit.ly/DeTres

Comedians Bonachera and Garza are partners, onstage and off. The game is partly a hands-off adventure game where you learn about their relationship, and watch it unfold over several nights, but it's also a series of interactive comedy gigs.

Playing as Garza, the younger and newer half of the double act, your job is to supply the punchlines to Bonachera's setups, building up his routines or delivering knockout follow-ups as the game allows. You're restricted by cards, which are dealt out during every gag, and for your every response you're given cards to choose from.

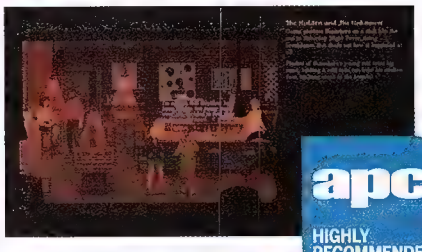
After every performance, we spend some time with the duo, picking what activity they get up to that evening. It might be heading to a bar, going back to their hotel room, or taking a walk, and it's refreshing to see a game explore a gay, established relationship in a mature way.

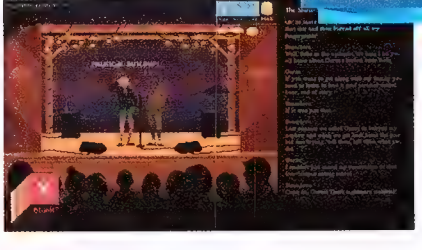
In a story about the unsaid, this narration feels essential, giving their relationship huge emotional weight. This is a fresh, original interactive story, and also somehow a basic deckbuilding game.

An insightful game about relationships and a novel deckbuilder. The former is more accomplished than the latter.

Tom Sykes

★★★★☆





HOME

Solving puzzles isn't a chore.

■ Free | PC | yumiicchii.itch.io/home

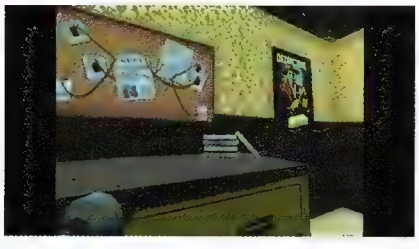
Home takes a long time to reveal its hand. Is it just a game about doing chores, or will it turn into a horror game? As a child staying in their house alone, you have to tick chores off a to-do list, and there's a cosy, homely feel to the game as you gather laundry, take the rubbish out and feed the dog.

The backstory is fun: you're too young to go to an escape room, so your folks have set you up some simple puzzles to complete at home. There are a couple of locked doors that need codes, and the answers are somewhere inside the house.

By poking around you are able to get a sense for the people living here, including the detective-obsessed protagonist, who even has one of those serial killer corkboards on the wall of their bedroom. The puzzles aren't overly complicated, but mainly an excuse to fully explore the house, before *Home* lays its cards on the table at the end of the game.

It was refreshing to play a horror-adjacent game that knows the value of restraint.
Tom Sykes

★★★½☆



IMMORTALITY

Art is a force that creates and destroys.

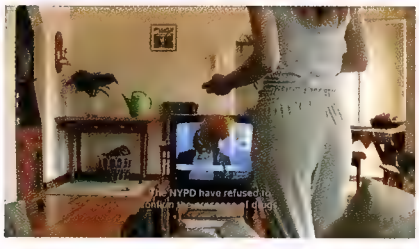
■ $28.95 | PC, iOS, Mac, Android, XBS/X | halfmermaid.co

Where does art come from? Does it come from within us, or is it all around us? This is the realm of philosophy that *Immortality* delves into as you unravel its FMV-led mysteries. It is presented less as a game and more as a box set of forgotten (and fictional) French model and actor Marissa Marcel's filmography.

Players begin with a question posed in the Short History of Marissa Marcel, written by *Immortality* director Sam Barlow: what happened to the actor? Why has she been absent for 20 years? Why were none of her movies released? Where is she now? Luckily, the answers may lie in the large cache of film Barlow and his crew – producer Natalie Watson and programmer Connor Carson – found back in 2020. "After carefully collating and scanning the footage," Barlow writes, "we have created this piece of computer software in an attempt to preserve this work and share it so that Marissa may live again in the hearts of audiences."

Players do not have immediate or comprehensive access to the entirety of the footage. Instead, they start with a single interview from a '60s-era late night talk show, and are expected to organically branch out from there.

The game itself is structured like a Moviola editing machine, and combined with an editing mechanic, the player is



able to put together their own 'supercut' based almost entirely on vibes. It's very satisfying to go down these rabbit holes on your way to solving the mystery at the heart of the game, and the sense that you are actively participating in this created world is bolstered by the presence of excellent background music that intensifies as you jump from scene to scene.

Immortality is a remarkable game, an interrogation into the human cost of art and a teardown of the film industry's rotten treatment of women and other marginalised people, past and present. It skewers the idea of the auteur, even as it mimics the form and formats of 'great artists' of the past.

Sam Barlow's best, most thought-provoking game yet, and a barnstorming debut for Half Mermaid.
Kaile Hultner

★★★★½

AS DUSK FALLS

A page-turner without pages.

■ $45.95 | PC, XB1/S/X | asduskfalls.com

On the face of it, this is a hard sell to the videogame crowd. There's no direct control over an avatar. You complete QTEs and make choices, and... that's about it, really. Yet the limitations of the format are transformed into strengths here. Once you're playing you'll want little more than to see what happens next. The story concerns two very different families brought crashing together during a small-town motel siege.

To explain much more than that would run the risk of spoilers which, in a game like this, could tear holes through the experience. As a motion comic, there's almost no full animation present.

Instead, what are essentially comic panels are presented one after the other with subtle fade-in transitions. I worried that this would break the atmosphere for me, but I got used to it almost straight away. Two words that constantly pumped through the heart of the game during my playthrough were intimacy, and pace. I quickly began to care about all of these people and what happened to them, and more than once I found myself agonising over a decision. I felt close to the people; close to the story; close to making a decision that I would regret. Similarly, with no possibility of the player becoming lost or distracted in the game world, the developer has huge control over the pace of the story – and they nail it.I still liked the way that my first attempt at the story turned out. Events and relationships ended in a messy, realistic way that I wish I could share with you, and as the credits rolled, I was already thinking about what I'd do differently next time, the ending I'd like to see, and how I might get there.

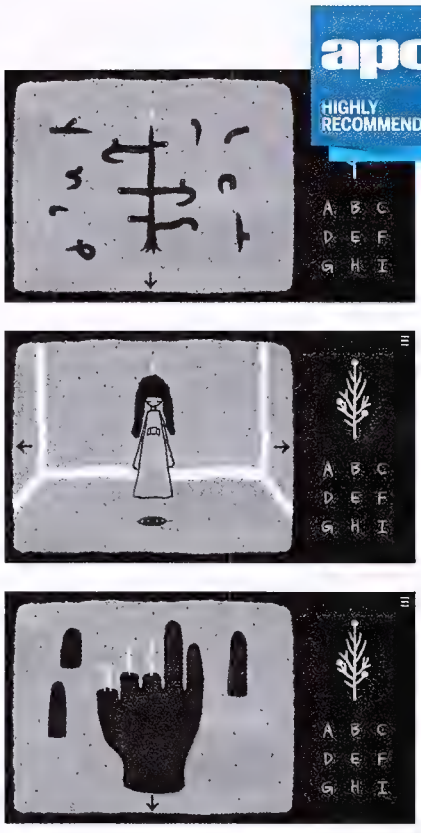
" Two words that constantly pumped through the heart of the game during my playthrough were intimacy, and pace."

If you're looking for a strong story that you'll want to replay at least once, and/or something to tide you over until we get that dishwashing simulator we're all waiting for, this is very much your game.

A gripping experience, despite an ending that is the equivalent of kicking itself up the arse.

Luke Kemp

★★★★☆



HER TREES

Make like a tree and get out.

■ Free | PC, browser | stonetreebook.itch.io/her-trees

There's value in stripping a game back to just the mouse cursor and some puzzling things. In adventure game *Her Trees* there are no keys or other items to collect. Instead, your inventory is letters of the alphabet – A to I – which you have to type in as the solution to every puzzle. Finding these passcodes is the tricky and quite ingenious bit, as clues are hidden in every orifice, in twisty bones or bits of twig, in empty pint glasses or torn-up missives.

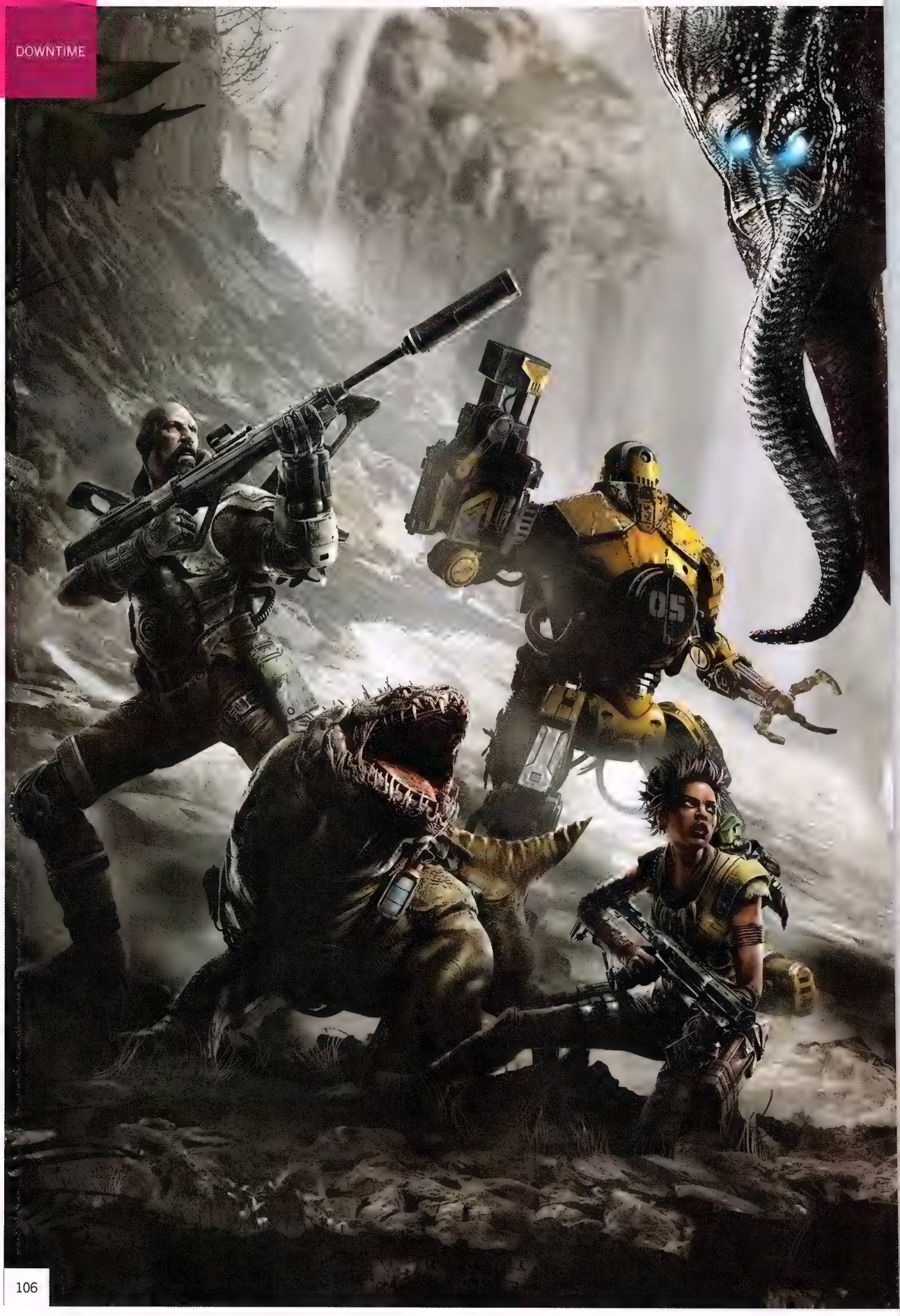
You discover these clues not by pulling levers or pressing buttons or twisting dials, but by dragging items around with the mouse, experimenting by piling this thing on that thing or moving this die by that die to form a pattern. The information is all there, you just need to piece it together, to arrange the constituent parts so they're just so.

The puzzles are clever, and all stuffed in one small and elegant room-escape style environment, revealing an ending that is brief and baffling.

A soothing atmosphere and lightly macabre puzzling making this a great place to linger.

Tom Sykes

★★★★☆


05

GAME CHANGER

Evolve

This asymmetric multiplayer didn't go extinct, its DNA is everywhere. Samantha Greer

■ **Release:** February 10, 2015 **Developer:** Turtle Rock Studios **Publisher:** 2K **Link:** 2k.com

Evolve came along too soon. It was definitely the victim of its own misguided marketing campaign, a push from its publisher 2K to front-load a season pass for DLC before the game had even been released. In our current climate of games saturated with passes of all kinds and microtransactions, Evolve almost seems quaint. It's more than business practices that came before their time, *Evolve* was ahead of the curve on a handful of design trends and while it might have died out, its DNA lived on.

2K recently, inexplicably, turned matchmaking back on for the game after years in limbo. It's in a bit of a sorry state, trapped in a transformation to free-to-play that never completed but once you're in a game, all these years on, it still absolutely shines. You might not think of it in light of its controversies at the time but *Evolve* was a unique, thrilling game. The team at the then newly founded Turtle Rock Studios were fresh off their work on *Left 4 Dead*, and applying it's knack for co-op shenanigans to a whole new beast. The premise is nicely simple: a team of four hunters are up against an ever evolving monster.

Natural selection

Its roster of hunters is broken up into a handful of roles. Trappers for tracking and locking the monster down, assault for bringing lots of damage, medics to keep their team alive and support who offer a wide range of buffs or assists. What's neat as I dive back in is finding that *Evolve* had something nailed down that *Overwatch* would soon capitalise on, having player roles and characters that weren't for twitchy shooter players. It allowed all sorts of people to play together. *Evolve* was never *Counter Strike* but still, it's welcome to have a game where people can contribute without having to master fine aiming.

I love playing as a medic, especially Caira, and focusing on creating areas of healing for my buddies. As *Overwatch 2* seems set to chase after high-level esports play and ditch the qualities that made it an approachable shooter for many, *Evolve* feels like a promise now unfulfilled in the larger multiplayer world. Their personalities are buried in the game's current state which treats every match like your first one, so always plays the tutorial voiceover instead of the banter that usually takes place while the hunters wait in the dropship as a match starts.

It pales a little compared with the richness of character *Vermintide* has served up so well in its co-op experience but its definitely in that ballpark, injecting life into something that

could've been bare bones. It's a fun way to flesh out a world we basically never see, filtering it through the perspectives of its cast so that the truth always remains a little out of reach.

A Kraken time

Then there are the monsters. Dead by Daylight has popularised asymmetric multiplayer and maybe if *Evolve* launched today, it would have found an audience ready to master these beasties. The Goliath and Behemoth are the vanilla, raw strength monsters but the Kraken, Wraith and Gorgon are all stranger, creepier foes that really complement the spooky atmosphere of its nighttime maps. Each match has the monster starting in its weakest, stage one form. Here it must rely on stealth, to stay hidden and eat wildlife until it can evolve. If it manages to reach stage three, it's nigh-on indestructible and hunters are really gonna have to bring their A-game to beat it. This provides matches with an arc that helps shape these hunts into something with momentum and pressure.

Finding the right team, in terms of players and their chosen characters, is essential for the hunters.

Traipsing around its jungles and icy forests (which still look very good in 2022) I'm even reminded of *Hunt Showdown*, stalking enemies, with birds and traps that can be triggered, alerting the monster/hunters to the presence of their foe. It's a unique kind of tension *Evolve* captures, something akin to those big buff lads in *Predator* being stalked by an alien foe while trying to hunt it. It's a dynamic that shifts throughout the match. A monster can quickly become the prey if trapped in a space that doesn't suit its abilities. Likewise, all it takes is a hunter to end up split from the group and they can become monster lunch. It's all about the moment-to-moment decision making, knowing when to be cautious and when to take those risks. There are few multiplayer games that bottle that tension so perfectly but *Evolve* is one of them.

HUNT LOWDOWN

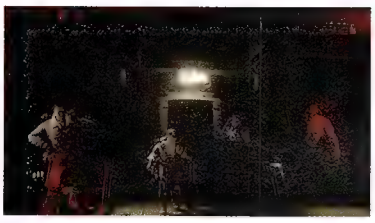
My favourites of Evolve's hunters

CAIRA DIAZ
MEDIC
Medics are my go-to in games, because they're not an option in many. Balancing healing and offence is rewarding, and so is Caira's grenade launcher.

SLIM
MEDIC
My other favourite. He's a bug man! He smokes! He has a little scarf! That's cool as heck. Plus he uses his wings to fly instead of a jetpack, that's neat.

IDA LENNOX
ASSAULT
This old lady is all tough charisma stuffed into a mech she calls the Thunderchild. It rules and in the right hands, she can beat up a monster alone.

MAGGIE LUMUMBA
TRAPPER
She's lean, mean and has a pet 'trapjaw' called Daisy who helps her track down monsters. Monsters are her bread and butter, tracking them down just feels right.



Above: At its best, *Evolve* produces memorable moments of daring feats or cunning plans.

Right: If you can't find a full lobby, bots are always an option.

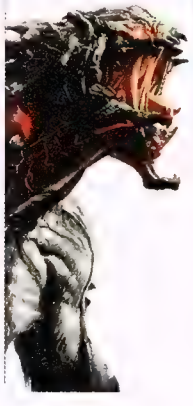
Bogged down

The downside is that sometimes a match winds up a slog as you make all the wrong choices chasing after a monster you can never quite catch. It's rare but it does happen. Yet without the possibility of a dull match, there'd be no room for all the wild heroics that make it worthwhile. Watching a Lennox main (she's an old lady in a mech) wind up the last remaining hunter and still go toe-to-toe with the monster for a win is a feat that feels like it belongs in a history book. Using a player to lure the monster into a trap was a bit of inspiration that paid off in spades.

If I'm talking a lot from the hunter's perspective it's probably because I don't find the monster nearly as much fun to play as. I like being the underdogs and even at its weakest, the monster is clearly a sizeable threat. This is the thrill for the players who do play as the monster, trying to become the ultimate villain. It's a lonely role though with none of the explicit power of being the killer in *Dead By Daylight*. You really need to be quite good to succeed as the monster and that simply means, not a lot of players are gonna take that role. Which doesn't mean nobody does and there are bots to play against, it just means that with the game's small player pool, finding a deadly match is tricky.

Clever girl

Even hunters don't have it easy though. Teamwork is essential thanks to the roles and playing with strangers is a real gamble than can bog a match down in misery if someone isn't doing their part. When the synergy is there, it's rewarding as hell but unless your playing with friends it's never guarantee. This was presumably *Evolve*'s flaw upon release. It is a demanding game even if, in terms of mechanics and skills, its relatively approachable. Strategy is where *Evolve* asks a lot. Anticipating your foes' moves is essential and it can be a cruel learning curve for anyone playing the game alone. Its this possibility space, for ambushes and deception, that make *Evolve* such a rewarding game though. I think in avoiding these frictions we wind up with games devoid of downtime sure, but you lose out on all the fun stories. *Evolve* isn't quite the story machine that something like *Hunt Showdown* is but its closer than so much else. It's not every game that gives me moments I recall years later.



At the time of publication you cannot get your hands on *Evolve* unless you already owned a copy. The player base is not in a position to grow. Given it already pivoted to free-to-play, I hope, that given their already inexplicable decision they go a step further and let a new audience find it. I doubt it can become a hit in 2022 (especially when its creators have moved on to other things like *Back 4 Blood*) but I suspect *Evolve* would do better in the current games landscape than it did back in 2015. Stranger things have happened. It feels like a game that's on the cusp of greatness, a few tweaks and changes, perhaps a sequel, away from nailing the formula. A shame then, given its name, that it just never got enough of a chance to evolve. ■

RETRO

Return of the Mac

How do you bring a classic Mac back to life? Developer Jarosław Mazurkiewicz tells David Crookes how and why he created MacintoshPi to do just that.

When the Raspberry Pi went on general sale ten years ago, the barebones, low-cost computer harked back to the past while looking towards the future. The idea was that users would learn how to program computers once more, evoking memories of the era of the BBC Micro, ZX Spectrum and a myriad other machines on which millions of people cut their coding teeth.

While many Pi users have done just that, the computer has proven fruitful in other ways. The various versions of the small single-board computer have formed the heart of many projects, from magic mirrors and weather stations to robots and orreries. But an ability to emulate vintage computers and consoles has arguably caught users' imagination the most.

The free software library RetroPie, for example, lets people revive the Amstrad CPC, Dragon 32, Commodore 64, Master System, Neo Geo, Oric, TRS-80 and Vectrex, among many others. Raspberry Pi has also in effect become a near-perfect Amiga thanks to the distro Amibian (**amibian.org**).

Recently, our heads were turned by a new tool created by Jarosław "Jaromaz" Mazurkiewicz called MacintoshPi. This open-source project allows users to run full-screen versions of Apple's Mac OS 7, OS 8 and OS 9 (all released between 1991 and 2001), and it does so complete with sound, an active internet connection and modem emulation.

A growing love

Jaromaz is an IT team leader for EuroLinux, a company building a Polish clone of the Red Hat Enterprise Linux distribution. He first came across Apple's computers in 1998. By that time, the company had only been selling its wares in the country for seven years. "Before 1992, Eastern Bloc laws restricted the flow of Western technology so, during my childhood, we only had access to ZX81, ZX Spectrum, Atari and Commodore computers," he told *APC*.

Jaromaz's project has enabled him to recreate a Macintosh Classic II.

Jaromaz connected Creative Pebble speakers as part of his setup.

Although a number of Polish schools snapped up Macintosh Classic computers when they became available, Windows PCs dominated. "My youthful memories are associated with Windows 3.1/95/98/ME and Red Hat Linux," said Jaromaz.

Yet when working in the Polish editorial office of PC Magazine, he was able to see Macintosh computers close up. "Mac OS systems were being used for the typesetting of newspaper titles and I used to watch these people working," he said. "Sometimes they provided me with Apple computers for testing."

It was a while before he reacquainted himself with Macs, however. "In 2015, I built a hackintosh with OS X Yosemite for testing purposes because I'd seen the Retina screens in Polish Apple Reseller showrooms and the resolution and readability of the fonts fascinated me," Jaromaz explained.

"The hackintosh convinced me of the Apple system itself – its attention to detail, cleanliness and visual perfection. Shortly after that, I purchased my first MacBook Pro with a Retina screen and I also installed the Basilisk II emulator to begin serious, long tests of Mac OS 7.5.5.

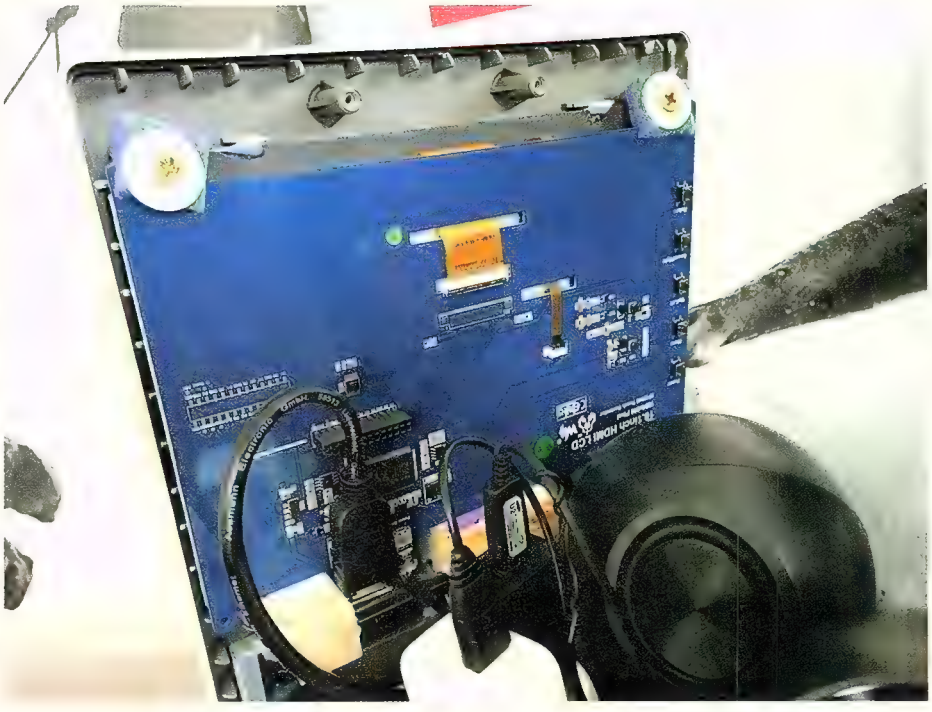
"I was surprised at how many programs and games worked seamlessly with the emulator

© Boris Artzybasheff, Time, Victor R Ruiz, CC BY 2.0

and I knew many of them from the PC I owned in my youth, although some were new to me. This gave me the chance to explore the most interesting Mac titles retroactively."

It was then that he fell in love with Mac OS 7.5.5. "It's so friendly, intuitive, elegant and easy to use," Jaromaz said. He dreamed of running the operating system with the original Macintosh Classic case.

"But as a software, not hardware, specialist, I didn't want to buy older and expensive hardware only to worry that it would have a short lifespan," he explained. "I believed a system emulated on a modern ARM board would successfully replace the original hardware and create a solution."



The screen was turned 180° to avoid a tangle of annoying cables.

Introducing MacintoshPi

Jaromaz tried to run the early Mac emulator collection Mini vMac on an iPad before finding it didn't allow the use of internet resources and handled the keyboard incorrectly. He then compiled Basilisk II in Xcode on his MacBook ("a version of the macemu/iOS branch by user Jesús A Álvarez") and found it worked on his iPad mini.

When he bought a Macintosh Classic II case on eBay, though, he discovered that the iPad mini's screen was too small, while standard iPads were too large and wouldn't fit in the case. "Apple also requires self-made software to be signed once a week, which makes it very difficult to use." The MacintoshPi project duly began.

Six years on and it's finally available. What's more, it's already attracting a lot of attention. MacintoshPi builds on top of the Basilisk II emulator, allowing Mac OS 7 and 8 to run. It also uses the open-source SheepShaver emulator from 1998 to run Mac OS 9, making for a versatile retro Macintosh package.

To install it, users need either a Raspberry Pi 2, Pi 3 or Pi Zero 2 W (it won't work on the original model and it's not compatible with Raspberry Pi 4 Model B at the moment). "Right from the beginning, the goal was Raspberry Pi 3B+," Jaromaz said. That's because he was able to draw inspiration from another project called BMC64.

"Raspberry Pi 3B+ is the best board for BMC64 – the fastest, low-level, bare-metal Commodore 64 emulator for Raspberry Pi," he explained. Created by Randy Rossi and based on another Commodore 64 emulator called VICE, BMC64 offers true 50Hz/60Hz smooth scrolling and low latency between input and video/audio. "Randy optimised it for Raspberry Pi and omitted Linux entirely, hence the bare metal," said Jaromaz, adding that he wanted to follow the same path.

"It contains minimal and imperceptible latency, and joysticks can be connected directly to the Raspberry Pi's GPIO, eliminating the additional latency of the USB interface." It became a model for how Jaromaz wanted MacintoshPi to work. For good measure, he ended up including a dual-boot option that supports the Commodore emulator. It can mimic a Commodore 128 and Commodore PET, too.

Hard work

To get MacintoshPi up and running, you simply need to compile and run a single script atop the legacy version of Raspberry Pi OS Lite. If you use the full legacy version of Raspberry Pi OS, you'd need to switch to the command line or set system start to CLI; the process is neatly explained on Jaromaz's GitHub (**github.com/jaromaz/MacintoshPi**).

Installing the packages takes about two hours, but the results are stunning. MacintoshPi bypasses the X.org manager and background tasks are reduced to a bare minimum ("the full resources of Raspberry Pi can be used," Jaromaz enthused).

MacintoshPi therefore boots and runs very quickly; if you put a Raspberry Pi running MacintoshPi next to a vintage Mac running the operating system, you'd be hard-pressed to notice any difference. But the task has not been an easy one, as you can imagine, especially given the scope of the developer's ambition.

"After compiling emulators under the Raspberry Pi, I encountered a number of problems," he said. "I was able to solve some of them after my experiences with these emulators acquired on MacBook and on iPads, but some required more work, searching for answers on forums or non-existent sites using the Internet Archive."

> "I was surprised at how many programs and games worked seamlessly with the emulator and I knew many of them from the PC I owned in my youth, although some were new to me."

The work was complex. "I had problems with building the correct images, with configuring

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Mac OS 9 isn't running on the Macintosh Classic II hardware but on a Pi.

system images for internet support, with appropriate configs for emulators, the correct options for compiling emulators and, separately, SDL2, because SDL2 from a package won't work in emulation," he continued.

"There were problems with performance, with the correct compilation of NetDriver, with versions of libraries (because they have to be legacy), with mouse movement delay and with sound." You sense he could go on, but he has managed to go into battle and beat each and every issue. Indeed, you could replace a broken vintage Macintosh motherboard with MacintoshPi (connected to a replacement display) and carry on as before.

And that's what Jaromaz has done. After restoring the yellowing case of his Macintosh Classic II using a solution that's 18 percent hydrogen peroxide, and appropriate light exposure, he fitted a 10.1in Waveshare 11870 1,024 x 600 LCD display designed to support Raspberry Pi. With the screen turned upside down so that the wires were out of the way, he added a Logitech MK295 Silent Wireless keyboard/mouse combo, which proved attractive because they use a single Bluetooth dongle. He also added a couple of speakers to the Raspberry Pi's analog audio/jack input and a splitter, then popped them inside the case.

Up and running

But what happens at startup? "A very important part of the project is the MacintoshPi Launcher, which overwrites configuration files for the emulator and Raspberry Pi itself, reboots the Raspberry Pi already at a resolution equal to that of the emulated system, and launches the actual emulator with Mac OS, as soon as the Raspberry Pi OS boots," Jaromaz explained.

"When starting Mac OS, the launcher – based on the resolution and selected system version – matches the appropriate startup chime (guessing, as it were, which Macintosh version the sound should come from) and plays that sound."

When Mac OS is launched at the same resolution as a Linux system, there is no need for resolution translation and no associated mouse lag. "For example, in the emulation of Macintosh Classic at its standard 512 x 342 resolution, mouse lag doesn't occur at all, which would unfortunately be the case if the resolution on the Raspberry Pi OS was set to, for example, 1,920 x 1,080," he added.

> "There were problems with performance, with the correct compilation of NetDriver, with versions of libraries (because they have to be legacy), with mouse movement delay and with sound."

"When you turn off the Raspberry Pi and restart it, it will still automatically boot the emulated Apple system. Only by exiting Mac OS and running a command such as mac pios or mac cmd would the Raspberry Pi OS (graphical or CLI version) be restored to automatic startup upon power-up."

While that means it's possible to flick between operating systems, the main attraction is the vintage Mac OSes. MacintoshPi is perfectly capable of running games such as *Lemmings*, *Age of Empires*, *Chessmaster 6000*, *Panzer General*, *Tetris* and more across the three Mac operating systems. It will also fire up Netscape Navigator and Outlook Express and allow users to enjoy Telnet, Internet Relay Chat and Bulletin Board Systems via the Virtual Modem. Steve Jobs would be proud.

"Modem emulation is an interesting feature of this project," said Jaromaz. "I applied the tcpser software used previously to Telnet BBSes within the VICE emulator, but

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the method of use seemed too complicated. Since I wanted modem emulation to work on emulated Mac OS systems as well, I decided to redirect the tcpser input to virtual device / dev/tnt0. Then the data can be read from another virtual device, /dev/tnt1, which becomes a virtual serial port in the system." It's also possible to connect a real CD-ROM drive – a matter of specifying a path to the drive in the configuration file. CDEmu software allows any CD/DVD image to be plugged in and they'll be handled automatically.

"After connecting the image with cdload image.toast command, a virtual CD drive will appear on the desktop of the emulated Mac OS," Jaromaz said. "Basilisk II and SheepShaver let you connect a floppy drive too, but I'm not sure how it would be mounted on Raspberry Pi.

"A workaround is to use the dd command and create a disk.img image of the floppy drive. Such an image can be plugged directly into MacintoshPi with a command such as mac os7 disk.img. After booting, a virtual floppy drive with the contents of disk.img image will appear on the desktop of the emulated Mac OS."

Mac OS images have been pre-configured to support online connections.

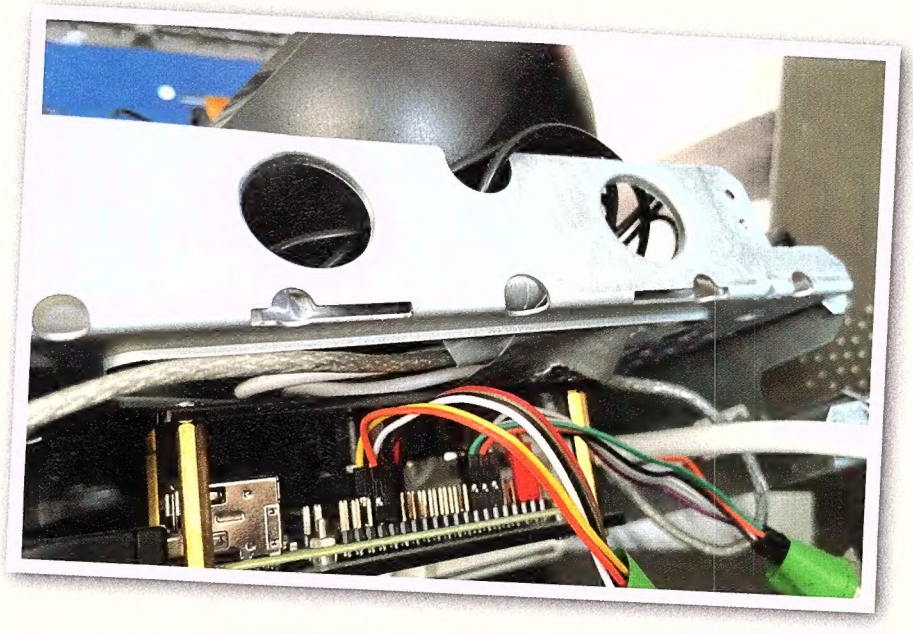
Place a Pi into an old Mac for a cool setup.

Tapping into nostalgia

Of course, going to such lengths isn't for everyone. Some people merely want a quick burst of nostalgia or to get old software to run in the fastest possible time. If you're among this group, you can go to system7.app in a browser to enjoy another recent Mac-related project called Infinite Mac, which is also based on Basilisk II. As its creator, Mihai Parparita said: "It's a golden age of emulation." And, if you're keen to relive the days of retro computing, the scene has never been so well supported.

"Nostalgia does play a big part in this – the opportunity to go back to the days of our youth," said Jaromaz. "It's a chance to recall the software we used in our childhood and bring back those memories. But it also taps into curiosity. It's much better to read and understand biographies of famous figures associated with Apple Computer Inc, for example, knowing how the systems worked and looked at the time. Oh, and it's great fun."

And that, we have to say, is more than enough for us. ■



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CHIP CHAT

JOEL BURGESS REPORTS ON THE UNUSUAL SIDE OF TECH NEWS

AI GENERATED SHORT FILM WINS CANNES JURY AWARD

AI takes the crow flightpath to generating Hollywood films.

A short video that was created using AI text-to-image generation from Belfast-composer Glen Marshall won a Jury Award at the Cannes Short film Festival in August. The moody three minute music video was based on an interpretive dance routine titled 'Painted' on YouTube and was accompanied by an original score. Marshal fed the YouTube video through OpenAI's CLIP software with annotations to make stylised outputs. *The Crow* video that resulted was largely edited and rearranged by the composer who said the raw outputs were often too focused. It's a pretty compelling proof of concept for a new future of AI generated films.

TEAMGROUP'S GLOBAL WARMING-PROOF MEMORY

The world may be burning, but TeamGroup's SSD will be cool AF.

You only have to turn on the news to see just how close scientists reckon an environmental apocalypse is, but thanks to TeamGroup at least we'll have some high megahurtz RAM and liquid cooled storage to combat any global warming that might be coming our way. TeamGroup is leading the way in liquid cooled memory modules that were specifically designed to combat the pesky greenhouse effect's impact on the perpetual operation of European data centres. The new Industrial Smart Alert DDR5 Memory Module and Industrial Grade VC Cooling M.2 SSD will basically be the only thing functioning properly in the unprecedented heat waves of tomorrow.

CHIP CHAT

Samsung support advises customer to drill or smash SSD

"You can drill a hole in the SSD or smash it with a hammer."

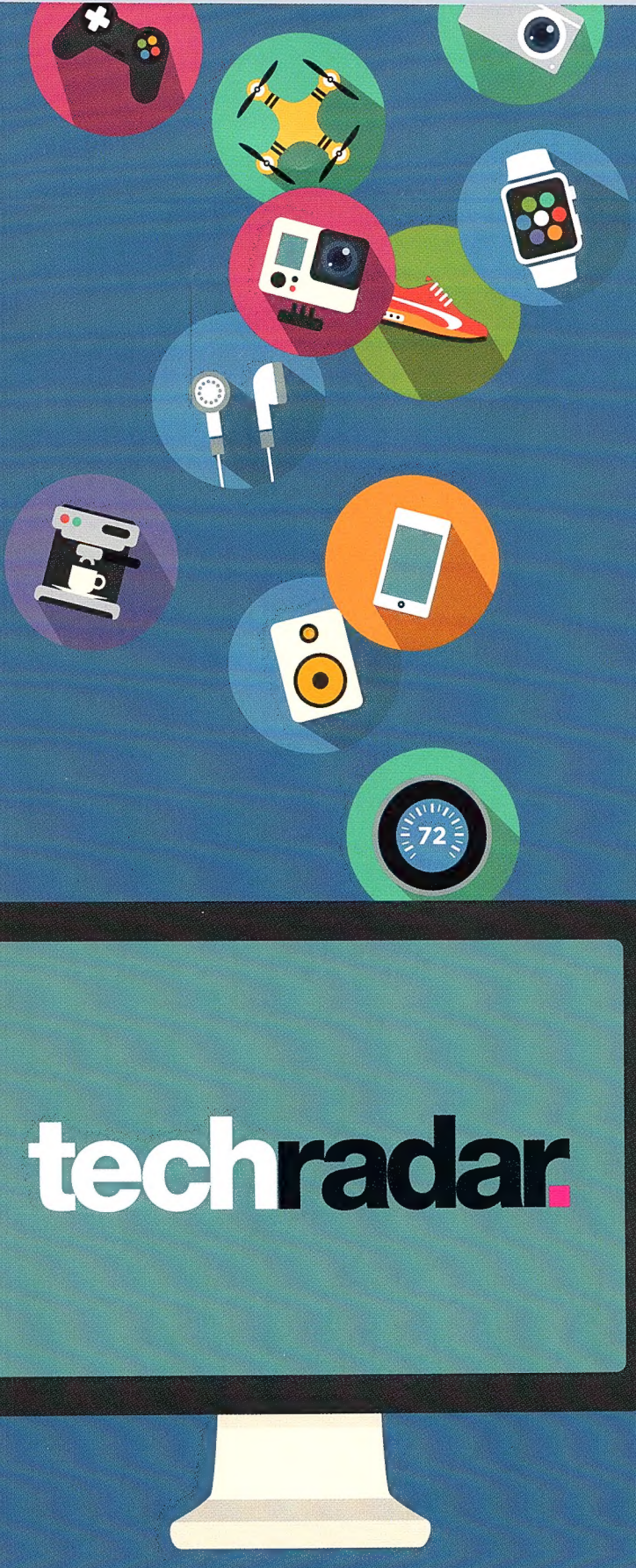
Usually when getting official support from a company on how to exchange a faulty product under warranty, you'll be encouraged to send a device back to the manufacturer 'as is', but when that device is a corrupted SSD containing highly sensitive material you might think twice about whether it's worth just buying a new drive. Fortunately a customer support staffer in Germany advised an *Igor's Lab* writer that they could destroy the SSD using a 'drill' or a 'hammer' before returning it to ensure the data remained secure.

This option was only offered after extensive testing to ensure the drive was faulty, so we wouldn't recommend drilling first and asking for a replacement later.

YOUTUBER CREATES A BFKEYBOARD

This big keyboard comes with Rick-key-rollover.

What do you look for in a keyboard? Are you after clicky mechanical switches, or a super slim noiseless membrane that's perfect for typing? Are you a button mashing purist that needs N-Key rollover, or do you just want something that'll allow you to wash all the crumbs out every once in a while? We know the list of preferences seems almost incomprehensibly long, but we're pretty sure no one ever asked for a keyboard that's 4.8 metres long. That didn't stop YouTube channel *RKade* from building one anyway. This Guinness World Record winning keyboard takes around an hour to type the lyrics to Rick Astley's 'Never Gonna Give You Up'. ■



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